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TRANSACTIONS
Kansas Academy of Science.

VOL. IX.

1883-84.

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TRANSACTIONS

OF THE

SIXTEENTH AND SEVENTEENTH ANNUAL MEETINGS

OF THE

KANSAS ACADEMY OF SCIENCE,

(1883-84),

WITH THE

REPORT OF THE SECRETARY.

VOL. IX.

TOPEKA, KANSAS:
KANSAS PUBLISHING HOUSE: T. D. THACHER, STATE PRINTER.
1885.

TRANSACTIONS.

THE Sixteenth Annual Meeting of the Kansas Academy of Science was opened in the Senate Chamber, in the Capitol, at Topeka, on the afternoon of Wednesday, the 21st of November, 1883, and was continued through that and the following two days. An abstract of the proceedings is given in the following pages, the papers accepted by the Publication Committee being printed in full.

The proceedings of the afternoon of the 21st were of a business nature, and included the presentation of reports by the officers, and the discussion of ways and means looking toward the enlargement of the usefulness of the Academy, and the proper growth of its museum and library.

A committee appointed to report on the revision of the constitution and by-laws of the Academy presented a draft, which, after slight modification, was adopted by the Academy. The following is the instrument as adopted:

CONSTITUTION AND BY-LAWS OF THE KANSAS ACADEMY OF SCIENCE.

CONSTITUTION.

SECTION 1. This association shall be called the Kansas Academy of Science.

SEC. 2. The objects of this Academy shall be to increase and diffuse knowledge in the various departments of science.

SEC. 3. Members of this Academy shall consist of two classes: active and honorary. Active members may be annual, or life members. Annual members may be elected at any meeting of the Academy, and shall sign the constitution, and pay an annual fee of two dollars. Any person who shall at one time contribute fifty dollars to the funds of this Academy, may be elected a life member of the Academy, free of assessment. Honorary members may be elected on account of special prominence in science, on the written recommendation of two members of the Academy. In any case, a two-thirds vote of members present shall elect to membership. Applications for membership in any of the foregoing classes shall be referred to a committee on applications for membership, who shall consider such application, and report to the Academy, before the election.

SEC. 4. The officers of this Academy shall be chosen by ballot at the annual meeting, and shall consist of a president, two vice presidents, secretary, treasurer, board of curators, and librarian, who shall perform the duties usually appertaining to their respective offices. The president, secretary, and treasurer, shall constitute an executive committee.

SEC. 5. Unless otherwise directed by the Academy, the annual meeting shall be held at such time and place as the Executive Committee shall designate. Other meetings may be called at the discretion of the Executive Committee.

SEC. 6. This constitution may be altered or amended at any annual meeting, by a three-fourths majority of attending members of at least one year's standing. No question of amendment shall be decided on the day of its presentation.

BY-LAWS.

1. The several departments of science shall be assigned to commissions, whose duty it shall be to report through their chairman at such time and place as the Academy shall direct. These reports shall include a brief summary of the progress of the department during the year preceding the presentation of the report.

2. The President shall deliver a public address on the evening of one of the days of the meeting, at the expiration of his term of office.

3. No meeting of this Academy shall be held without a notice of the same having been published in the papers of the State at least thirty days previous.

4. No bill against the Academy shall be paid by the Treasurer without an order signed by the President and Secretary.

5. Members who shall allow their dues to remain unpaid for two years, having been annually notified of their arrearage by the Treasurer, shall have their names stricken from the roll.

6. One-fourth of the income of the Academy shall be set aside for the increase of the library—all purchases to be first authorized by the Executive Committee.

7. The Librarian shall have charge of the distribution, sale and exchange of the published "Transactions" of the Academy, under such restrictions as may be imposed by the Executive Committee.

8. Eight members shall constitute a quorum for the transaction of business.

A committee appointed at the opening of the session to nominate the officers for the ensuing year, returned the names of the following persons, who were duly elected by the Academy to the respective positions:

President—R. J. Brown, of Leavenworth.

Vice Presidents—F. H. Snow and Joseph Savage, of Lawrence.

Treasurer—A. H. Thompson, of Topeka.

Secretary—E. A. Popenoe, of Manhattan.

Board of Curators—O. H. St. John and J. T. Lovewell, of Topeka; J. H. Carruth, of Lawrence.

On the evening of the 21st the retiring President, Dr. A. H. Thompson, delivered an address, which, on account of the importance of its information concerning the growth of the Academy, and by a departure from the usual course of the Publication Committee in such cases, we here print:

ADDRESS OF THE RETIRING PRESIDENT, DR. A. H. THOMPSON, OF TOPEKA.

Subject: "THE ORIGIN AND HISTORY OF THE ACADEMY."

Mr. President, and Members: In compliance with the requirements of a by-law adopted at our last annual meeting, it becomes my duty at this time to perpetrate what is by courtesy therein designated as "the President's retiring address." This peculiar diversion, thus legalized, was instituted and made obligatory upon the occupant of this chair upon his retirement, by way of following the custom prevalent in other societies, and especially in scientific associations, of exacting this tribute from this officer. It is, perhaps, in some sense, a sort of peculiar price to be paid over at the close of his term of office, as a return for the honor and dignity thrust upon a modest member by his election to the highest office within the gift of the Society. In the present instance, the price is paid down as a feeble and inadequate expression of the high appreciation and estimation in which this, the highest honor within the gift of the Academy, is held by the retiring incumbent.

In most scientific associations, the honor of election to the presidency is imposed as a timely and appropriate recognition of scientific attainments and discoveries, and it is often most worthily bestowed, as the practice in the highest associations in this country and in Europe illustrates. But in all confidence, I am obliged to confess, that in the present instance I cannot perceive that this has been the case, much as I regret the fact; and it becomes, in view of this, a gift of courtesy and not of deserts, and is therefore the more appreciated.

Former presidents of the Academy have at times given volunteer addresses upon their retirement from office; but the custom does not appear to have been constant nor at any time obligatory. These addresses have been in the nature of popular lectures upon scientific subjects, and with but little reference to the Academy, its needs or wants. But presidential addresses are now made legal, and will be exacted from all occupants of this chair hereafter. This is therefore the first penalty under the new law, and the opening performance in the series of addresses which are to follow from successive presidents. This fact suggested to my mind that no more appropriate subject—since I was obligated to have a subject—could be selected for the first of the series than the history of the Academy.

A glance into the past years of the Society, and a sketch of the steps leading to its organization, its early days, and its subsequent history: nothing of this sort has been at-

tempted, so far as I could ascertain, except a brief sketch in the Eleventh Annual Report of the Department of Public Instruction for 1871, (page 181,) and as that is brief and now twelve years old, it seemed appropriate to the occasion to take the subject up again, and also, in order to make it more complete by further research, to bring it up nearer to date. In addition to the interest we naturally have in everything pertaining to our early history, this work appeared the more imperative, as much that is of interest and value is being lost by the death or removal of the first members of the Society, the chief actors in its organization. As I proceeded to investigate the history of the first years, I was deeply impressed with the need of some such effort being made for the speedy collection and preservation of the facts and incidents connected therewith, as much valuable matter I found was never recorded, but is only preserved in the memories of a few persons. Some links in the chain of interesting incidents and events are even now irretrievably lost: some lie buried with the dead, others are known only to members scattered to the ends of the earth. But the fragments I have endeavored to collect, and the result it is my pleasure to present to-night.

Much relating to the early days of science and the Academy has been recorded, and of this I have of course made free use; but in addition to this, I have communicated with some of the organizers and early members, and other persons in possession of needful facts and incidents, who have, so far as I could hear from them, been uniformly kind, and freely contributed of their knowledge. I take this opportunity of publicly thanking them for their patient kindness and assistance. Without their aid I could have done little or nothing, and to them must be accredited all that is new in my offering. There is much, of course, that I have been unable to find, and I hope those members who know or can procure anything in addition, will feel it their duty to record and preserve such knowledge without delay. My résumé is by no means exhaustive, and with this explanation I will hasten to submit it.

One of the earliest reports published of systematic scientific work in the region now included in the State of Kansas, if not indeed the very first, is that of Prof. G. C. Swallow, of St. Louis, and Major F. Hawn, of Leavenworth, upon the result of several years' collecting in the Territory of Kansas by the latter gentleman. The report "On the Rocks of Kansas," was presented to the St. Louis Academy of Sciences, February 22, 1858. Maj. Hawn says, in his note added to the report, that he began collecting fossils as early as 1855. This date must surely entitle him to the honor of being the first scientific worker in the State. His results were forwarded in 1857 to Prof. Swallow, and a certain division to Prof. F. B. Meek, who reported his examinations and discoveries to the Albany Institute, March 2d, 1858. These reports contained much of interest and value in their day, and in addition to their scientific interest to us, have served as a groundwork, and supplied data for later investigations and explorations.

After this first special report upon the geology of Kansas, various fragmentary articles upon the subject of natural science, and the resources of the region, were published in different periodicals, railroad survey reports, etc. Of these I cannot attempt to give you a list, as they are scattered and incomplete, and of various degrees of importance. The new papers of those years also contained notices and articles on scientific subjects of no little value; but these are still further beyond cataloguing.

The next important and special report upon the geology of the State was that of Prof. B. F. Mudge, in 1864. It is called the "First Annual Report on the Geology of Kansas," by B. F. Mudge, State Geologist. It is an epitome of the scientific and practical results of the geological exploration of that year, conducted by the means of a small appropriation made by the Legislature of the preceding winter for that purpose, as per Acts of 1864 (ch. 63, p. 109.) Considering the means at his disposal, (he expended only $2,000,) the results are excellent; but all who knew the man are not surprised that he should have produced so much from so little. The report was necessarily preliminary and general, but

it was a good start for a grand work, which should have been continued; and it is a stain upon the vaunted intelligence and enterprise of our people that it was not resumed long ere this.

The survey was organized with the following *personnel* (*Journal of Education*, vol. 1, page 125): Professor B. F. Mudge, State geologist; Maj. Frederick Hawn, assistant superintendent; Prof. G. C. Swallow, paleontologist; Tiffin Sinks, M. D., chemist and meteorologist; C. A. Logan, M. D., botanist, and the sanitary relations of the State.

The *Educational Journal* adds that "the geological corps is composed of gentlemen whose literary merit is unquestioned, and who are in every way well qualified to discharge the duties severally assigned them. We greatly need a thorough geological survey of the State, and if it could discover nothing but coal and salt, we would be richly repaid for the cost. The appropriation is small, too small to enable it to be at all thorough; but if the scientific men of the State will aid all they can it will do much to increase its thoroughness. We would call especial attention to the request published in this *Journal* to send botanical specimens to Dr. Logan. Much can be done in this way to aid each department in gathering information.

"The mineral wealth of our young State is the property of its inhabitants. Providence has distributed these bounties for the benefit of his creatures, and placed them just far enough below the surface of the earth to promote our industry and education. Success to our geological corps."

The *Educational Journal*, by the way, did much to promote a healthy love of nature in those days, and abetted the early struggles of science in the State not a little. It published many scientific articles, encouraged the geological survey, and was in every way the friend and helper of scientific research.

Prof. Mudge's report for 1864 was published by Hon. John Speer, of Lawrence, the State Printer, in 1866. It has now become very rare and difficult to obtain, and I am indebted to the courtesy of the State Historical Society for the privilege of examining a copy in their invaluable collections.

Prof. Mudge's work was conscientiously done, and as thoroughly as a most economical disposition of the public funds set apart for the purpose, and supplemented by his private contributions to the expense of his explorations, would allow. The report was a most valuable exposition of our economic resources and of the scientific knowledge then attainable, and will long stand as an honor to the early days of science in Kansas.

In 1865, Prof. G. C. Swallow published a report on the Geology of Miami county, Kansas, issued, I think, in Kansas City. In 1866 he also published a report upon the Geology of Kansas, which was printed by Jno. Speer. He was appointed under an act of the Legislature of 1865, (ch. 40, p. 89,) authorizing a survey. This work, owing to the troubles on the frontiers, was confined to the eastern part of the State, and was, he says, mainly a continuation of his work in connection with the geological survey of Missouri. It was also largely an extension of his report upon the collection of Major F. Hawn, published in 1858. This last report is supplemented by a contribution on geology by Maj. F. Hawn; one upon the sanitary relations of the State, by Dr. C. A. Logan; and one also by Dr. Tiffin Sinks, upon the climatology of Kansas. As a whole, the publication is of great scientific and historical interest. It is quite rare now, as much so as Swallow's "Rocks of Kansas."

These reports contain the bulk of the scientific work accomplished, and represented about all there was known of our natural resources up to the time of the organization of the Academy. From them and from the various scientific articles contributed to the miscellaneous periodicals of the State, we learn what was the scientific condition of the field in which it was proposed to start a scientific society. The material which would render such an organization possible, we should at this distance of time consider rather meager; we can but wonder that it was attempted at all. But the founders were en-

thusiastic and hopeful, and the result justified the wisdom of making the efforts at that time. The enthusiasm of two men in their love of nature seems to have been the main cause of the inception of the enterprise and of the attempt to organize it. I refer, of course, to Prof. B. F. Mudge and Prof. J. D. Parker, the originators and founders of the Kansas Natural History Society. It is something for the scientific men of the State to be proud of, that a society devoted to scientific investigation and the popularization of science should have been organized thus early in the history of the State; that it has been sustained through all the vicissitudes incident to the career of such a society for sixteen years without missing a single meeting; that it has an honorable record for efficiency and usefulness; and that it has promoted the study and investigation of nature throughout the State. All credit and honor belong to the founders, and it is our pleasure to improve every opportunity of rendering them all just honor and the acknowledgment of our indebtedness.

Prof. J. D. Parker was the principal actor in the origination of the Society, and to him is due its suggestion, inception, and exertions. He writes me:

"The conception of the Society was original with me. The name, 'Kansas Natural History Society,' I derived and adopted from the Illinois Natural History Society, of which I had been a member. I moved the resolutions enlarging the scope of the Society and changing the name to 'Kansas Academy of Science.' I enlisted Prof. Mudge as the first recruit in the new movement, after I had visited him and thoroughly discussed the whole subject. I published the first articles in reference to organizing such a society. I wrote out, circulated and published the 'call' for the first meeting. I called the first meeting to order, and nominated Prof. Mudge as chairman, and afterward as President. I helped draft the constitution and by-laws; acted for the first five years as Secretary; edited the first report published by the State Board of Agriculture; demanded that Alfred Gray should make it a coördinate branch of the State Board of Agriculture, thus preserving the autonomy of the Society; and signed as Secretary the official paper to the Secretary of State when the Academy became a State organization.

"I worked on the organization several months, and then wrote to Prof. Mudge about it; but he thought it was too early in the history of the State to organize such a society. Prof. Alex. Winchell had failed to organize an Academy in Michigan, and Prof. Mudge was justly cautious."

But there is one man to whom we are more indebted, perhaps, than to all other causes combined, for all that we have and all that we are; one who was at once the best, the wisest, the grandest man whose name ever graced the annals of science in Kansas. I refer of course to Professor Benjamin F. Mudge. Any mention of the Academy or of its past work or purposes without naming Professor Mudge, would be, to use a vulgarism, "like the play of Hamlet with Hamlet left out." The name and work of the Academy are inseparable from the name and work of Professor Mudge. Its very existence is due to the affection he had for it and the care he bestowed upon it. It is an honor of which we shall ever feel proud, that our organization should have been the care of such a man; that he was mindful of it in the days of its weakness; that its prosperity gratified him, and that he considered its welfare before all other societies which were honored by his membership.

Personally the fullest praise can do scant justice to his many superior qualities of mind and heart; words cannot portray his delightful presence, his genial face, his well-stored mind and his boundless kindness and enthusiasm. But he is gone, and we have left only the memory of his inspiring presence, our undimmed affection, and the ever useful record of his works. And how we miss him at every step; the void is yet painfully vacant four years after his untimely death. How we used him in every undertaking to counsel and help us! His loss to the Academy and to science in Kansas can never be estimated. It is scarcely too much to say that if he had lived that we would have had a geological survey before this; for his extraordinary popularity throughout the State, and the profound respect and regard in which he was held by all classes of intelligent people, would have gone far towards securing that much-desired enterprise.

I have collected some reminiscences of our dear friend and benefactor in connection with notes gathered relative to the steps taken toward the organization of the first Natu-

ral History Society and its history. They are from my gleanings, from contributions by different friends, especially Mrs. Mudge, and from personal recollections. "The first brief report of the geological survey of Kansas gives an outline of his early scientific labors in the State of his adoption. . . . It was during the war, and attended with many difficulties. The field was new, and the geological features entirely different from those to which he had been accustomed in his New England home. Though harder for him, it only added zest to his enthusiasm, and he bravely overcame obstacles which would have discouraged one less in love with Nature and her laws. His own wants were few and simple. With public funds he was strictly conscientious, yet the appropriations for the survey were so small as to hamper him greatly, and he supplied provisions for the early part of his trip from the home larder to lessen expenses. His travels were sometimes perilous, and frequently involved very hard labor. He was much perplexed when he had the main part of the report ready, to find that characteristic specimens, which he had sent to the paleontologist carefully labeled, had been disarranged or lost, so that, after embarrassing delays, the report was finally put through the press incomplete. He never despaired of having more generous appropriations from the State, when he or some other geologist would complete so important a survey." . . . "In lecturing he prepared his thoughts with care; but once having clearly fixed in his mind what he wanted to say, his retentive memory had no further use for the notes." And how much we did enjoy those lectures! How the memory of them hangs like a fragrance about the walls of even this dingy capitol building, where we have listened to him year after year! How contagions and inspiring was that exhaustless enthusiasm to all the young men with whom he came in contact! It was my privilege to have him for a near friend for many years, and many are the precious moments, in private conversation as well as in public lectures, that I have sat drinking at the fountain of knowledge which flowed in charming streams from his lips. How well I remember a day, years ago, when he came hurriedly into my office, on Kansas avenue, all aglow with excitement, to inquire if I had seen the tracks on a piece of Osage flagging which was being used as a crosswalk on the avenue at Sixth street. I was loth to admit that I had crossed and recrossed on the stone with the rest, and like them had never noticed the tracks; but we went together to see the stone, and sure enough there were the marks, as distinct as could be, and his beautiful enthusiasm was at its height. That was one of the first examples he had seen of these tracks, which he afterwards investigated and described so charmingly. He dropped all his affairs, went directly to the quarries the very next day, and procured a quantity of the rocks with tracks.

"While State Geologist, the delightful experience of discovering hitherto unknown fossils and the valuable economic deposits of Kansas, awakened in him a strong desire for the formation of scientific societies, not only for a wider dissemination of knowledge of these resources, but the preservation within our own borders of such rare specimens. He improved every opportunity by lectures and conversations to encourage a growing interest in science. The large area and the few railroads were discouragements to most people regarding a State organization, with perhaps a lack of interest. He really longed for the scientific companionship which he had enjoyed in the East from boyhood — the libraries, public societies, parlor clubs, field meetings of the Essex (now Peabody) Institute, long botanical excursions with congenial companions — how much he missed them! But in 1867 Rev. J. D. Parker Professor-elect of Lincoln College at Topeka, spent some weeks at Manhattan. He was fresh from his studies and an enthusiastic lover of nature, and together with Professor Mudge they prospected and walked, talked and planned." It is probable that it was at the tea-table of Hon. I. T. Goodnow, with Professors Mudge and Parker, that the subject of a Natural History Society for Kansas was first broached. That is Mr. Goodnow's recollection of it. Prof. J. D. Parker writes in his obituary sketch of Prof. Mudge in the Kansas City *Journal of Science* (vol. 3, page 570), that,

during the summer vacation of 1867, he first became personally acquainted with Prof. Mudge, when, by special invitation, he "spent three royal weeks" at his home in Manhattan. The days were spent in scientific rambles and in making collections in the vicinity, and the nights until a late hour in discussing scientific subjects. During this visit was matured the plan for organizing the Kansas Natural History Society, which afterwards grew into the Kansas Academy of Science. Of this organization Prof. Mudge was elected the first President, and was again President at the time of his death. "During those twelve years he was unwearied in his labors for the Academy, always cherishing plans for its development and growth, and whose success formed one of the most joyous experiences of his life. In no organization did he take a greater interest, and he has come in from the plains, hundreds of miles, bronzed and travel-worn, to attend its meetings."

The next step of which I am aware was the publishing of the following letter, in the *Journal of Education* for March, 1868, (vol. 4, page 268:)

A NATURAL HISTORY SOCIETY.

Editors Journal of Education: Allow me to call your attention to the importance of forming a Natural History Society in our State. The benefits flowing from such an organization would be various, among which I will mention the following:

1. It would afford means of associated effort.
2. It would give inspiration to naturalists.
3. It would afford opportunities for exchanges.
4. It would diffuse a spirit of scientific research.
5. It would put the State in direct communication with the various scientific bodies of the country.
6. Large collections would ultimately be made by such society, which would be permanently secured to the State.

Has not the time arrived for the friends of natural science to move in the matter? Some of the leading naturalists of the State are favorable to the organization of such a society at an early day. The State authorities would doubtless aid such a society in publishing valuable reports and in storing collections. Very truly yours, J. D. PARKER.

In my pursuit of material, I have been fortunate enough to induce Prof. Parker to favor me with a record of recollections, which I will read *in extenso:*

FORT STOCKTON, TEXAS, August 20, 1883.

Dr. A. H. Thompson, President Kansas Academy of Science—DEAR SIR: Cheerfully I comply with the request contained in your favor of August 10th, and give what information I can in regard to the first meeting of the Kansas Academy of Science, and the preliminary steps which led to the organization of the Society.

When I was called in April, 1867, to Lincoln College, Topeka, there was no scientific association in Kansas, and no general interest in science apparent in the State. The people of Kansas had suffered intensely in the border strife followed by the civil war, of which at Topeka there were still evidences in the rifle pits along the southern edge of the town, and in the palisades still standing at the intersection of Kansas avenue and Sixth street.

Prof. B. F. Mudge, of the Kansas Agricultural College, had published a report on the geology of the State, and another report had been published by Prof. G. C. Swallow, late of the University of Missouri; Prof. Frank H. Snow had recently been called to the University of Kansas. These scientists and some others were pursuing various lines of investigation, but there was no organization to bring them together to secure the results which flow from associations. I was impressed with the necessity of some society to accomplish this object. I determined, if possible, to organize a State Scientific Society. After agitating the matter several months, and not meeting any encouragement at Topeka, I wrote to Prof. B. F. Mudge, who replied that his heart was with us in the work, but he feared it was too early in the history of the State to organize such a society. Accepting an invitation to visit him during the long vacation, I spent three royal weeks at his house in Manhattan, where we discussed the subject very thoroughly during our scientific rambles in that neighborhood. Before my return, Prof. Mudge promised to go into the movement. Satisfied with his indorsement and promised coöperation, I returned home, and set the matter before the people of the State through the public press. In due time a call was published and circulated, which received the signatures of various scientific and public men of the State, to hold a meeting in my recitation room in Lincoln College, Sept. 1, 1868. A great storm occurred two days before the meeting, which threatened to interfere with it. But Prof. Mudge came down the day before the meeting full of enthusiasm in the new movement, and the meeting was held at the appointed time, with a very small attendance; but we organized the Kansas Natural History Society, of which Prof. Mudge was elected the first President, and I was elected the first Secretary.

For two years Prof. Mudge and I struggled hard to keep the association alive, for we had great mis-

givings in regard to its very existence. Public attention was often called, through the press, to the importance of sustaining it, and wherever we lectured in the State we always presented the claims of the Society.

The first annual meeting was held in the First Presbyterian church, at Topeka; but there was a very small attendance, and little enthusiasm. It was in fact a very gloomy time with the Society. There was little or nothing in the treasury, and none seemed to care for science. But Prof. Mudge was full of faith in our final success, and said we "must not despise the day of small things." We agreed to go on notwithstanding the discouragements, and determined that we would not say "fail" until we actually did fail. The officers were unanimously reëlected—for there was great unanimity in those days, where two or three votes settled the whole matter.

During the following year we worked faithfully in trying to establish the Society, but with very little encouragement from the public. Everybody was busy about something else, and science was left to take care of itself. At the end of two years, we received an invitation from Prof. Snow, indorsed by the three professors of the State University, to hold the annual meeting at Lawrence. We gladly accepted the invitation, and the meeting was so well attended, and such a desire expressed to enlarge the scope of the Society so as to include every line of scientific investigation, that it was so ordered. The name was changed, at a subsequent meeting, to the Kansas Academy of Science. Several excellent papers were read at that meeting by Profs. Mudge, Snow, Bardwell, and others, which were worthy of any veteran society. The meeting was one of joyful interest on the part of those who had labored amidst so many discouragements, for we believed that the permanency of the organization was now fully assured. The growth of the Society has, in fact, outrun all our early anticipations, and from this time the history of the Academy has been very generally known by the people of the State. Students of science, in almost every line of investigation, have come forward, and gladly carried on the work of the Academy, making original contributions in almost every department of science. But while we greet this ever-important work of scientists, and give them all honor for their invaluable contributions, we must not forget the importance of the work wrought by Profs. Mudge and Snow in the early history of the Society.

The subsequent action of the Legislature in making the Society a State institution, and giving it a room in the Capitol building, was unsolicited, but was a well-deserved recognition by the State, of science and the Academy.

In this connection, will you pardon me for saying, that the ultimate success attending the organization of the Kansas Academy gave me encouragement, when I moved to Kansas City, to try and repeat the work there. For seven years I was permitted to work on amidst the whirl of a large and growing city, in discouragements, in trying to lay the foundations of the Kansas City Academy of Science, whose interests are so intimately interwoven with that of the Kansas Academy. If the people of Kansas and of Kansas City will continue to cherish their Academies so that they shall become a blessing in coming years, and if these Academies will remember that they are closely related in origin, interest and work, and ever have towards each other those fraternal relations which should characterize scientific societies, I shall be amply repaid for my efforts. Fraternally yours, JOHN D. PARKER, *Post Chaplain.*

"Prof. Parker's location at the State capital favored the idea which Prof. Mudge had long cherished, of a central organization, and the result was a call for a meeting at Topeka." The following "call" was issued July 6, 1868. It reads: "*State Natural History Society.*—We, the undersigned, desirous of securing the advantages arising from association in scientific pursuits, and of giving a more systematic direction to scientific research in our State, hereby invite all persons interested in natural science to meet at Topeka on the first Tuesday of September next, at 3 P. M., at the college building, for the purpose of organizing a State Natural History Society. Signed by John Fraser, S. F. Chapin, D. H. Robinson, B. F. Mudge, J. A. Banfield, J. D. Parker, D. Brockway, J. R. Swallow, J. H. Carruth, R. D. Parker, Jeff. Robinson, Peter McVicar, F. H. Snow, Prof. Whitman, Richard Cordley."

The meeting was held pursuant to the call, as described by Prof. Parker. In a recent letter from him (from Fort Hays, where he now is), in reply to the inquiry as to the names of those in attendance at the first meeting, he says: "Very few were present at the first meeting. Prof. Mudge was the only person who did not belong at Topeka. Prof. J. A. Banfield was our first curator. Two or three students of Lincoln College were present, Mr. Billard and Mr. W. J. Stringham, the latter a mathematician of fine promise, and now professor of mathematics in the University of California. The few others I cannot remember." It is probable that Mr. Brockway was present. They were few in attendance, but the Society of Natural History—later the Academy of Science—was organized, and has increased in interest and good works until it now holds a position

of which every devotee of science in the State should be proud. The meeting was held in the recitation room of Prof. Parker, in Lincoln College, later Washburn College, which is the stone building yet standing southeast of the capitol square, on the corner of Tenth and Jackson streets. The building was purchased by the city of Topeka when Washburn College moved into its new building, southwest of the city, and has since been used as a public school.

The minutes of the first meeting are of such interest that I have transcribed them from the Secretary's record, and are as follows:

"Pursuant to a public call, the naturalists of the State met at Lincoln College, Topeka, Kansas, September 1, 1868, for the purpose of organizing a 'State Natural History Society.' A preliminary organization was effected, with Prof. B. F. Mudge temporary chairman, and Prof. J. D. Parker temporary secretary. The secretary then read letters from different naturalists in the State, regretting their necessary absence, and pledging their coöperation. The whole matter was then fully discussed, and the meeting resolved to proceed at once to organize a State Natural History Society. A constitution and by-laws were read, discussed, and adopted. The officers elected for the following year were: President, B. F. Mudge; Vice President, Prof. Whitman; Secretary, J. D. Parker; Treasurer, F. H. Snow; Curator, J. A. Banfield. On motion, Drs. D. C. Freyer and Geo. H. Sternberg were elected honorary members. It was then resolved that each member of the Society is expected to present a paper on some scientific topic at each annual meeting. The executive committee were directed to provide a public lecture at each annual meeting.

"On motion, adjourned. J. D. PARKER, *Secretary*."

The following constitution and by-laws were adopted at this meeting:

"CONSTITUTION.

"ARTICLE I. This association shall be called the Kansas Natural History Society.

"ART. II. The object of this Society shall be to increase and diffuse a knowledge of the natural sciences, particularly in relation to the State of Kansas.

"ART. III. The members of this Society shall consist of two classes—active and honorary. Active members may be elected at any regular meeting of the Society, and shall sign the constitution, and pay an annual fee of one dollar. Honorary members may be elected on the written recommendation of two members of the Society.

"ART. IV. The officers of the Society shall be chosen by ballot, at the annual meeting, and shall consist of a president, vice president, secretary, treasurer, and curator, a majority of whom shall constitute the executive committee.

"ART. V. The annual meetings shall be held at the capital of the State, at such times as the Executive Committee shall designate.

BY-LAWS.

"SECTION 1. Each branch of natural science shall be assigned to some member of the Society, who shall make an annual report on the same, and assist the Curator in arranging the specimens in a cabinet.

"SEC. 2. No bills of the Society shall be paid by the Treasurer without an order signed by the President and Secretary.

"SEC. 3. No meeting shall be held without a notice of the same being published in the papers of the State at least thirty days previously.

"SEC. 4. Special meetings of the Society shall be called at such time and place as the Executive Committee shall direct."

The following additional by-law was subsequently adopted:

"SEC. 5. Members who shall allow their dues to remain unpaid for three years shall have their names stricken from the rolls, having been notified by the Treasurer."

Following the constitution in the Secretary's book is a roll of the members, giving their names, residence, age, nativity, occupation, and other items—a most curious and interesting record as we look back upon it now. It comprises an extensive list of names up to the present, with an extremely varied assortment of ages, occupations, etc. Many of them, alas, have now passed out into the shadows of the beyond! The honored name of Professor Mudge heads the list of members; Professor Parker comes next, and then follow the names of many who have been active in the work of the Academy, and many who have never since been heard from. Many of our most active members now, recorded themselves, when joining the Academy, as simply "students"—a most significant occupation, and prophetic of the useful future in store for them.

The next meeting was held, pursuant to the call of the Executive Committee, in the Presbyterian church, at Topeka, September 7th, 1869, the President, B. F. Mudge, in the chair. Professor Snow writes me that "at the meeting of 1869, I remember that there were but three members present on the first of the two-days session. These were Professors Mudge and Parker, and myself. Several new members were voted in, and took part in the proceedings of the Academy. It is probable that Dr. R. J. Brown, of Leavenworth, was also present."

The old officers were unanimously reëlected.

The Secretary gave a *résumé* of the operations for the year, of making arrangements with other societies for exchanges, etc.; and in this connection it is interesting to note that even yet periodicals are occasionally received directed to the "Natural History Society" of Kansas.

Professor Mudge read a paper on "The Internal Heat of the Globe," which was much discussed.

In the evening, Professor Mudge stated at length the objects and needs of the Society. A paper was read from Mr. Edward Cave on "Solving the Higher Equations," and Prof. J. D. Parker delivered the lecture of the evening on the "Antiquity of Man on the American Continent," which was followed by other opinions on the subject.

Professor Mudge exhibited a fossil elephant tooth, found at Manhattan, and described such occurrences. (*Educational Journal*, vol. 6, page 131.)

The third annual meeting was held in the University building, at Lawrence—the old building, I presume—September 5th, 1870, Professor Mudge in the chair. The additions to the membership, and also the attendance at this meeting, were very large, and the town was lavish in its hospitality to the visiting members. Professor Fraser delivered a lecture in the evening upon "The Aims, Organization and Advantages of Scientific Association." He suggested the enlargement of the scope of the Society to embrace the whole field of science, not the natural sciences exclusively; and a committee was appointed to carry out the suggestion.

The next morning, papers were read by Prof. J. H. Carruth on "A List of the Plants of Kansas;" Prof. F. H. Snow on "The Fishes Found in the Kaw River, at Lawrence;" Prof. J. D. Parker on "The Internal Heat of the Globe," and others.

In the afternoon, papers were read by Professors Saunders, Carruth, and Mudge.

Officers for the following year were elected as follows: President, John Fraser; Vice President, B. F. Mudge; Secretary, J. D. Parker; Treasurer, F. H. Snow.

In the evening a lecture was delivered by Rev. James Burrows, on "Hugh Miller on the Workingman's Education." Prof. Fraser, who was born in Cromarty, gave some recollections of Hugh Miller.

The meeting was very successful, as the Lawrence meetings have always been, owing to the great assistance of the University people and the appreciation of the residents of Lawrence.

The fourth annual meeting was held in Leavenworth, in the Board of Education rooms, on the morning of October 25, 1871; President Fraser in the chair.

In the afternoon the President gave an address upon "The Physical Constitution of the Moon," which was much discussed.

In the evening the President made some remarks upon the "Influence of Science upon Civilization," and Prof. Snow lectured upon "The Claims of Natural Science."

On the morning of the second day, "Additions to the Flora of Kansas" were reported by Profs. Snow and Carruth and Mr. John Wilson. Prof. Snow presented a list of the "Birds of Kansas," 163 species then known.

In the afternoon papers were read by Profs. Parker, Mudge, and Wherrell.

The officers were reëlected, with the addition of Dr. R. J. Brown as Second Vice President.

The Committee on Organization, appointed at the last meeting, submitted the following changes in and additions to the constitution and by-laws, which were adopted:

"ARTICLE I. This Society shall be called the Kansas Academy of Science.

"ART. II. The object of this Society shall be to increase and diffuse a knowledge of science, particularly in relation to the State of Kansas."

Section I of the by-laws was amended to read: "The general sciences shall be assigned to sections, whose duty it shall be to report through their respective chairmen, at such times and places as the Secretary shall direct."

It was agreed that the Mercantile Library Association of Leavenworth be an authorized agent of the Academy, to receive all such scientific specimens as may be offered for the use of the Society, and to preserve the same subject to the order of the Society.

In the evening Prof. Mudge gave a lecture upon the "Geology of Kansas."

The meeting was quite successful, and many persons were admitted to membership.

It is a noteworthy fact that about this time the leading men of the Academy were very active in disseminating scientific knowledge, and the papers and periodicals of the State of those years are filled with scientific articles from Profs. Mudge, Snow, Carruth, Parker, and others. They did a great deal of useful work in this manner, which in our day has borne good fruit.

The fifth annual meeting was held at Manhattan, opening at 7:30 P. M., October 8th, 1872, in the Congregational church. The President and Vice President being absent, it was called to order by the Secretary, and Professor Snow was elected temporary chairman.

Papers were read by Professor Robinson and Colonel Tweeddale.

On the morning of the second day, Professor Mudge, Second Vice President, presided.

Additions to the flora were made by Professors Carruth, Snow, and Mr. Popenoe. Mr. Joseph Savage gave an address on "The National or Yellowstone Park." The officers were reëlected.

During the morning and afternoon, papers were read by Dr. Saunders, Professors Mudge, Snow, Parker, J. H. Lee, and others.

On Wednesday evening, Rev. Charles Reynolds delivered a lecture to a crowded house upon the "Agreement of the Bible with Geological Science."

The meeting was a great success, and the enjoyment of the members complete. (*Educational Journal*, vol. 9, page 221.)

The *Educational Journal* has good reports of the most of the meetings for these years, and which were not published in volume form.

The sixth annual meeting was opened in the Presbyterian church, at Lawrence, on the evening of September 8th, 1873, President Fraser in the chair.

President McVicar, of Washburn College, delivered a lecture upon "Darwinism."

In the morning the meeting was held in the University building. Miss Detmers read a paper on "The Action of Lime on Soils," and Professor Mudge one upon "The Mound Builders."

One of the most important results of this meeting was the formal acceptance by the Academy of the provisions of the act passed by the preceding Legislature, making the Academy a coördinate department of the State Board of Agriculture. The act is as follows:

"The Academy of Science shall be a coördinate department of the State Board of Agriculture, with their office in the Agricultural rooms, where they shall place and keep for public inspection the geological, botanical and other specimens; the same to be under the direction and control of the officers of the said Academy of Science. An annual report of the transactions of said Academy of Science shall be made on or before the 15th day of November of each year to the State Board of Agriculture, for pub-

lication in the annual transactions of said Board. This section is to be inoperative and void unless accepted by said Academy of Science, in writing, signed by the President, and attested by the Secretary thereof." (Ch. 137, sec. 2, Laws of 1873.)

The formal acceptance was duly accomplished, and the Academy since that time has been a coördinate branch with the State Board of Agriculture. Our proceedings since then have been published by the State in connection with, and also in separate volumes from, the report of the Board. Our museum, such as it is, is in a room adjoining that of the Board.

In the afternoon, papers were read, specimens exhibited, etc.

A resolution was adopted establishing relations with local scientific organizations as auxiliary societies. This was brought about by the application of the Topeka Scientific Institute for such recognition.

Attention was called to the matter of securing a set of standard weights and measures, which are provided by Congress for each State. They were afterwards procured, and used for a time at the University for comparison and sealing of private sets; but the standards were afterwards ordered to be brought to Topeka by the Legislature, and now repose somewhere in the bowels of this building. When the Academy obtains a museum room worthy of the name, they can be set up and be of some use; but there is no place for them now. It is the intention to have each county provide a set proven by these standards, with which private dealers will be obliged to compare their weights and measures and have them sealed as being of legal standard. The Government standards should not be used except for comparing county standards.

Entomology began to loom at this meeting, and the exhibit by Prof. Snow was very fine.

In the evening interesting addresses were made by Professors Stimpson and Mudge, and Dr. Reynolds.

Officers were elected as follows: President, F. H. Snow; Vice Presidents, J. A. Banfield and J. D. Parker; Secretary, John Wherrell; Treasurer, R. J. Brown; with curators and commissions.

This meeting was exceedingly interesting and successful, owing to the efforts of the University men. It is of especial interest to me personally, as it was my first meeting, and when I joined the Academy, which makes this the tenth anniversary of my membership—my jubilee year! It was under the guidance of Mr. Popenoe that I met Profs. Mudge, Snow, Savage, Fraser, Bardwell and others, whose names are suggestive of very many delightful hours. Ten years make many changes, and with the Academy and its *personnel* the changes have been marked—many of them painful to recall as we think of those who are gone.

The seventh annual meeting was held pursuant to adjournment, at Topeka, October 5, 1874, where all the meetings have been held since then. This, as well as the subsequent meetings, have honored me by holding the first afternoon or business meeting in my office. The attendance was good, and many were admitted to membership, among them Prof. Geo. C. Merrill, W. K. Kedzie and Geo. E. Patrick, of fragrant memory.

In the evening a lecture was delivered by Prof. H. B. Norton, on "The People and Landscape of the Glacial Age," in the old Representative hall at the Capitol, where the popular lectures were given for many annual meetings, while day meetings were held in the Senate chamber. The lectures were sometimes given in the Senate chamber, and once in the Baptist church, just east of the Capitol.

The morning and afternoon of the second day were fully occupied with the reading of many valuable papers. In the evening Rev. H. C. Hovey lectured.

The eighth annual meeting was held October 12, 1875. Very many valuable and interesting papers were read, and lectures delivered by Prof. Snow on "Meteors," and Prof. Mudge on "Darwinism."

The attention of the Academy was called to the need of a geological survey, which was discussed, and resolutions adopted urging it.

Prof. Snow was continued as President, and Prof. Mudge as Vice President; Prof Kedzie was elected Treasurer, and Mr. Joseph Savage Secretary.

The meeting was very successful, and well attended.

The ninth annual meeting was held November 14, 1876. The feature of this meeting was the lecture of Prof. C. V. Riley, upon "The Rocky Mountain Locust." The officers were reëlected. It was resolved to hold semi-annual popular meetings of the Academy.

The evening of the second day Prof. Bardwell delivered a lecture upon "Our Neighbor, the Moon."

The first semi-annual meeting was held in Leavenworth, in June, 1877, and was addressed by Profs. Snow, Mudge, and others.

The tenth annual meeting was held at Topeka, October 11, 1877, and was also characterized by an extensive array of valuable papers. Prof. Mudge delivered a lecture upon the "Value of Science," and Prof. G. E. Patrick one on the "Chemistry of the Sun."

The second semi-annual meeting was held at Kansas City, June 6, 1878, as the guests of the Kansas City Academy. The events of the meeting, which were exceedingly enjoyable, were a lecture upon "Rocky Mountain Geology," by Prof. Mudge, and upon "Steam Navigation," by Prof. Bardwell, and an excursion to and examination of mounds in Platte county, Missouri.

The eleventh annual meeting opened at Topeka, October 8th, 1878. The first evening's lecture was by Prof. B. F. Mudge, upon "The Rocky Mountains and their Fossils," and that on the second evening by Prof. D. H. Robinson, upon "The Historical Value of Linguistic Study." These were given in the Baptist church. Twenty-five papers were read at this meeting. Appropriate resolutions were passed upon the deaths of Profs. John Fraser and F. W. Bardwell, which had occurred since the last meeting. Two valuable and active members were lost to the Academy.

The twelfth annual meeting was held November 6th, 1879, at which a good programme was presented, and a numerous attendance had, both of members and of the public. Prof. Mudge, who had been President for a year, was reëlected. He delivered an interesting lecture in the evening, upon the "Mound Builders of North America."

On the second day Prof. J. H. Canfield gave a lecture upon "The Relation of the State to Higher Education."

This meeting was eventful as being the last at which Prof. Mudge was present. He died while in office, as its President. This lamentable event transpired upon the 21st of the same month of the meeting, November, 1879, exactly four years ago this very evening, making this the anniversary of the sad event. His funeral was largely attended by the members of the Academy, and none knew better than they the irreparable loss the people of the State had sustained. His death was the greatest calamity the cause of science in Kansas has ever experienced, for he did more for its advancement than any other person, or, perhaps, all others combined. And that he was appreciated abroad as well as at home, the following significant incident will illustrate. Shortly after his death, Mrs. Mudge, received from Dr. C. A. White, of the United States National Museum at Washington, advance sheets of their proceedings for 1879, containing descriptions of two new cretaceous fossils discovered by Prof. Mudge, *Gervillia Mudgeana*, sp. nov., (plate 5, figs. 3 and 4,) and *Pteria salinensis*, sp. nov., (plate 5, figs. 1 and 2.) Page 292 of the proceedings has this foot-note:

"While these pages are passing through the press, the sad intelligence comes that Prof. B. F. Mudge

is dead. He was a sincere devotee and an intelligent interpreter of nature, and better still, an honest man. Peace to his ashes.—C. A. W."

These words, expressing the appreciation of the man by the scientific world by one capable of understanding him, are in striking contrast with the estimation of another set of persons, who did him a gross, stupid injustice at the Agricultural College. A peculiar interest attaches to the shells mentioned above. They were among the latest collections of Prof. Mudge, while yet Professor of Geology at the Agricultural College; but after he left they were thrown out with other rubbish, "old bones and old stones," as the College President termed them. Not long before Prof. Mudge's death, he, in company with a friend, revisited for the first time the old College grounds, and looking over a heap of debris, his quick eye at once recognized the familiar specimens, and though some years had elapsed, he remembered the locality in Saline county where he had obtained them. Considering them new to science, he recovered and sent them to Dr. White, of the National Museum, who described and named them. Of the one mentioned in honor of Prof. Mudge—*G. Mudgeana*—he says: "It presents one more, among other now known similar cases, of evident genetic relationship between the Molluscan Fauna of the Dakota Group, and that of the later cretaceous groups of the West, which were formerly unknown, but which the discoveries of Prof. Mudge have done more than that of all others to show." How grateful to our ears is this tribute to our dear friend from one so high in science, and how satisfactory to have his own opinion corroborate our own.

During 1880 and '81 a committee appointed by the Academy secured sufficient funds by popular subscriptions to erect a monument over Prof. Mudge's grave at Manhattan, which was appropriately dedicated after the meeting in 1881. It was a pleasant duty to thus honor the last resting-place of our beloved friend.

"He was a man, take him all in all,
We shall not look upon his like again."

Of the last four years there is little to be said of the Academy that is not fresh in your memory. The meetings have been held each year in Topeka, and have been full of interest; valuable papers have been read and popular lectures have been sustained as usual. The principal matter of interest has been the constant effort put forth to secure the passage of a bill for a geological survey, of which the State stands so much in need. Last winter a special endeavor was made, but success has not yet crowned our efforts. The Academy now stands well, and is known throughout the entire scientific world. The publications are sought after by the scientific men and institutions of this country and of Europe, and the most of them are on the exchange list.

This prominence and honor is due to the reputation of the earnest workers we have in our ranks, who are doing good work in studying and classifying the products of nature in the various departments, and also to the fact that we occupy a most important field geographically. This is a responsibility which we recognize, and we endeavor by all means in our power to discharge our duty in the matter, to science and to the people of the State. Most fortunately the men have risen to do the work, and have cultivated the field with honor to themselves and to the Academy.

In the furtherance of our work one thing remains for us to accomplish before our honor and dignity shall be complete, and that is the geological and scientific survey of the State. That is one main object of our existence, and toward its accomplishment we must labor continuously until success shall crown our efforts, as it is certain to do. We must agitate the subject in season and out of season, until we obtain final victory. It is a duty we owe to ourselves, to the State, and to science.

NORTON COUNTY,

to accompany Report on the Geology of the County by Robert Hay

NOV. 1883.

PROCEEDINGS OF THE SECOND DAY,

NOVEMBER 22, 1883.

The President, Mr. Robert J. Brown, in the chair. The following papers were read:

PRELIMINARY REPORT ON THE GEOLOGY OF NORTON COUNTY, KANSAS.

BY ROBERT HAY.

Made to the Kansas Academy of Science, Topeka, November 21, 1883.

INTRODUCTORY.

Having, in the month of August, to take charge of the County Normal Institute, at Norton, I found myself, in the early part of that month, on a dull, half-drizzly day, descending from the high prairie down the somewhat steep slopes to the valley of Prairie Dog creek. The peculiar weathering of some rough rocks near the roadside attracted my attention, and called to mind similar appearances in Trego county, and I at once determined to work out as far as possible the geology of the county in which I was about to take a sojourn.

My opportunities were exceptionally good. A medical man, Dr. E. M. Turner, was sufficiently interested in the subject as already to have made some collection of fossils, and to give me a drive out in his buggy nearly every afternoon, and with me to devote several entire Saturdays to exploration. At the end of my sojourn, the results were already so definite, that on representation of the facts, I was encouraged by our President to remain a little while longer to give some sort of completeness to my investigations, for the benefit of the Academy. The finding of a very fine lower jaw with a nearly full set of teeth just at the end of my prolonged visit made it certain that there would be full repayment for any amount of investigation, and caused Dr. Thompson and Dr. Brown to agree with me that it would be well to secure the fossils for our Kansas museum, and to desire that I should return and secure them, Dr. Brown kindly making himself responsible for the cost. The results of my explorations in both these visits are stated in the following report, to which I will only further premise, that my journeys have extended over the entire county — from the Nebraska line to the boundary of Graham county, and from close to the eastern border to within less than one township of the western frontier; and the relations of the strata were determined by observations in more than thirty definite localities, fortified by many accurate measurements and careful estimates made on the spot. There is a certain definiteness about the geological phenomena that leads us to consider this a typical county, a knowledge of whose features will enable us to determine the more readily those of several others in the same northwestern region.

REPORT.

Norton county is situate in our northern tier of counties, and contains by the survey 900 square miles. It includes the first five townships in each of the ranges west of the sixth principal meridian numbered from 21 to 25 inclusive. It is the fourth county from our Colorado boundary, and the 100th meridian passes through it. The elevation of the surface is between two and three thousand feet, as is shown by Professor St. John's contour map, in the last Biennial Agricultural Report.

In considering the geology of this county, we shall investigate it under the following heads:

1. Potamography,
2. Stratigraphy,
3. Paleontology,
4. Economic Geology,

and shall do so with as much brevity as is consistent with definiteness of statement.

1. POTAMOGRAPHY.

Norton county has three principal streams, which pass through it in a direction nearly parallel to each other, viz., from the west to the north of east. They all enter from Decatur county, the Sappa, the northern stream, entering within two miles of the northwest corner of the county, and crossing the northern line into Nebraska about eleven miles from that point. Prairie Dog creek enters at the southwest corner of town three, passes through all the five ranges, and enters Phillips county at the northern line of town two. The North Fork of the Solomon river is the most southern of these streams, and it has rather less northing in its course than either of the others, its exit into Phillips county being less than five miles further north than its entry from Decatur. Its course is entirely in town five through each of the ranges. The tributaries of all the three streams are but small creeks which cut deep ravines into the body of the high prairie which separates the three valleys. The tributaries of each of the three main streams are longer on the northern than on the southern side of the basin, which means that the main streams are situated nearer to the south than to the north side of their drainage areas. A glance at the map shows this. Connected with this fact is this other, that the slope of the divide towards the northern stream is steeper and more abrupt than the slope towards the southern one. These facts are true also of neighboring counties, and also of streams in more distant parts of the State, and also in regions far removed from our State boundaries. The same facts of the stream seeking the southern side of its trough, and the steep escarpments of that southern side, are true also of many short tributaries of tributaries in Norton and other counties. For the explanation of this we must seek not merely to understand the effects of recent erosion, but go back to continental if not terrestrial causes operating in the ages we call geologic.

In the absence of any regular survey, it is difficult to form estimates of the relative elevation of the beds of these main streams, yet it is generally believed in the county, by intelligent persons, that the valley of the Prairie Dog is higher than that of the Solomon, and that of the Sappa than either of the others. Also, that the divide north of each stream is higher than that on the south; *i. e.*, there is a general increase of elevation of the surface *northward*. The direction of the streams is proof that it also increases westward. The Central Branch U. P. Rly. runs up the Solomon Fork as far as Lenora. The report of its engineers, kindly furnished by Superintendent Fagan, enables us to estimate the westerly ascent. The difference of elevation between Edmund and Lenora is 156 feet, which gives an increase of about 14 feet to the mile. The elevation northerly is not much less, that of Prairie Dog valley being probably 150 feet higher than that of the Solomon, and that of the Sappa from 80 to 100 higher than that of the Prairie Dog. This fact has a bearing which will be noticed further on. The exact figures which determine the full value of that bearing, can only be arrived at by a survey with instruments of precision.

The final fact of the Potamography of Norton county is, that the valleys are all valleys of erosion. Every depression below the level of the highest of the high prairie is due to the erosive action of water, aided by those agencies of varying temperature, force of wind, and other things we include under the term *weathering*. This erosion lays bare the face of the rocks in the ravines, and the study of it gives us the information necessary to illustrate our second head, viz.:

2. STRATIGRAPHY.

We recognize in Norton county six distinct strata, two of which belong to Niobrara

cretaceous; two others have so small a development that it is difficult to place them. They are above the Niobrara, present some cretaceous appearances, but may possibly be either Lignitic (Laramie) or positively Eocene. The other two are Tertiary. The modern alluvium is of course present in the valleys and ravines, and may be counted as a seventh stratum. Beginning with the lowest, we will briefly describe each:

No. 1. Is in its best development before weathering, a rather dark-bluish or lavender-colored shale. It is in some places very friable and brittle, in others tougher, and passes into a clay shale. Its color is much changed on exposure, becoming lighter, and in its upper layers inclines to buff. It contains a large-sized inoceramus both in the Sappa, Prairie Dog and Solomon outcrops, but we have only seen fragments. It has also numerous fish scales and fin spines, and occasionally the vertebra and teeth. We have seen a few saurian teeth, and have found in it the beaks of odontornithes—toothed birds—of at least two species. As already indicated, this stratum outcrops in each of the main valleys of the county, but in the Prairie Dog valley its upper layers lie low in the bed of the creek, and it is from wells that we have obtained its best appearance. In the Sappa valley it has a little more elevation, and in the Solomon valley it reaches from the river bed to a height of about 30 feet above it.

This blue shale passes gradually (and conformably) into the stratum above, which is mostly a bright yellow chalk. The change from one to the other is so gradual in some places, as to make it difficult to say where the line is. In other localities the line is so definite that some slight irregularities suggest unconformability, but further examination removes the idea. The greatest distinction we have observed is at two places, widely separated. One, Miller's Spring, west of Lenora, where a fine stream of water comes from under the chalk from the top of the shale; the other on the Sappa, where a depression in the shale of a few feet across is followed by all the streaks of the chalk, which is here beautifully banded. This little depression seemed to me just such a one as is often seen on the seaside sands, where a little stream entering the ocean makes its little furrow in the region between tide-marks. As it is to-day, so it was in the old Cretaceous sea.

No. 2. We very soon gave this stratum the name of the Yellow Chalk. It is chalk, and it is mostly yellow. We have seen since that Professor Cope has used the same designation for it, and this name will suit it well. It becomes in places in the southeast of the county, and over in Rooks and other counties, white; but buff and yellow are the prevailing tints. There are patches and layers of a brick-red and various shades of brown, and, in bright sunlight, a rich orange. The play of colors in some outcrops is perfectly gorgeous, particularly at Cedar gulch and Ghost creek, on the south side of the Solomon. At the latter place the bold escarpments of the chalk lying over the shale, both in contour and color, suggested a sunset by Claude Lorraine. At Norton Mill we were able to measure the thickness of the chalk. It is there about 55 feet. On the Sappa it is nearly as thick, but nowhere on the Solomon did we find it reach half that thickness, and in the southern valley it nowhere reaches so low as the line of the water in the river bed. It comes nearest to doing so at its most western outcrop, west of Lenora. This stratum presents abundant evidence of metamorphism of rock by infiltration. It has had its upper surface extensively covered by materials containing much silica, and through the cracks and water-holes water charged with silicon has percolated, penetrated the porous chalk, and changed it into various silicates, jasper, agate, and other forms. We have seen a band of fine red chalk changed into a band of jasper, the yellow streak above still remaining chalky. In crevices, (as also in the shale below,) crystals of calcite and baryta are found, and sometimes small crystals of quartz. In many of the occurrences of the chalk the upper layers are altogether silicified. In one place, northwest from Norton, these hard layers contain many cavities which are large enough for wells, and, containing much water, are so used. Many of the apertures through which water has entered

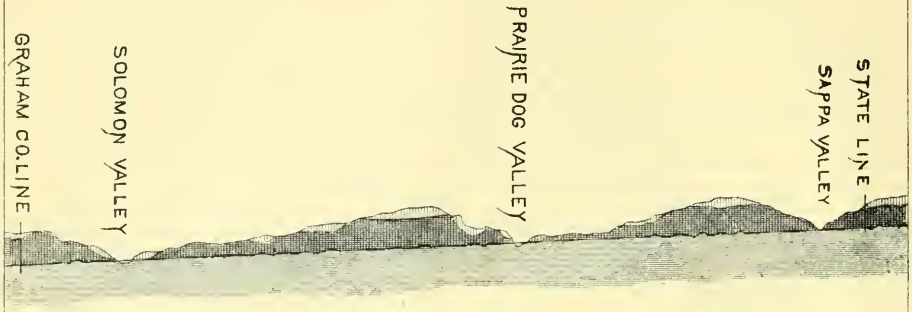
these wells are closed, and some nearly closed, by the deposit of the minerals in solution, of which silicon was among the chief—allowing us to trace the double action of water, first in wearing out a channel, and then in closing it up. The fossils of this yellow chalk are the same as in the blue shale, with the addition of the characteristic Ostrea congesta and the gigantic Haploscapha grandis.

No. 3. Is a greenish sand, which bleaches in weathering. We have found it in only in two localities certainly, and in neither place do we see it on the chalk, but it is within a few feet of where the chalk must be. We have found in it no fossils.

No. 4. Is a green clay shale, with streaks and patches of yellow; and in the outcrop where we first found it, it has a black, carbonaceous line, persistent for several rods. This green shale lies directly on the green sand in two out of three places where we observed it (both on the Prairie Dog); but in the other place, eighteen miles away, it lies directly on the chalk. Possibly the green sand is a local premonition of the green shale. The shale is about six feet thick.

No. 5. Is the ruggedest rock of the county. It occurs in bold ledges and rough crags. It is, however, very various. Prof. St. John refers to it as "irregularly bedded." This is strictly accurate. Nowhere in all the county have we seen it so that it could be described as stratified. Yet in escarpments of ten to twenty feet it gives several layers decidedly harder than the other parts, and these weather out into hard ridges. Varying much in character, it everywhere contains both sand and lime. We have called it the calcareous grit. In some places the grit is so coarse that it becomes a conglomerate held in a limey or clayey paste of various degrees of hardness; in others the sand is finer, and the lime in such quantity that it will do for mortar, and sometimes it is native lime with so little grit that it is used for plastering inside walls. It often contains limey or chalky nodules of great hardness and very tough. Again, it hardens into a building stone, and in other places its cliffs of sand have only lime enough to harden and whiten the weathered surface; and everywhere it contains cylindrical concretions, which Prof. Cope thinks may have been roots. The thickness of this No. 5 is not less than 200 feet. It comes down to within 30 or 40 feet of the level of the main streams, and in some places it is at or near the top of the high prairie. The Twin Mounds, in the Solomon valley, near Lenora, show a section of it for at least 150 feet to their very tops. A well twenty miles north pierces it to a depth of 130 feet. The wild cañons cut into it show its thickness to the same extent. The various qualities of this formation make it weather into bold and fantastic forms. In a wild ravine, southwest nine miles from Norton, it has been cut and carved by sun and wind and water into such varieties of shape, that the feeblest fancy may see turreted castles, pinnacles of churches, archways, battlements and towers. From one appearance as a cowled priest, we have named it, with the acceptance of the citizens of the county, *Monk's Cañon.* The most wonderful part of this formation is, however, its fossil remains. It is a burying ground of mammals! Here are jaws of rhinoceros, teeth of horses, shells of enormous turtles, bones and tusks of mastodon. It is the Loup Fork Miocene, the upper part of the Middle Tertiary. In 1878, Professor Mudge suggested that this formation in Trego county was possibly Miocene. (First Biennial Agricultural Report, p. 55.) Four years earlier, Prof. E. D. Cope described it as it occurs near the Colorado line, and without finding fossils, said it was probably Miocene Tertiary, (Cret. Vert., p. 19,) while at the same time he made a distinction between Miocene and Loup Fork, (p. 13.) Now the doubt is all gone. Professor Cope pronounces the jaw before us *Aphelops* from the Loup Fork Miocene. It will need further investigation to decide whether Professor Cope's Ticholeptus and Procamelus beds are distinctly marked in Kansas. One important feature remains to be noted: this Miocene is *erosively unconformable* with the strata below it. The surface of the yellow chalk was worn away to the extent of scores of feet, and left very rough by a long period of sub-aerial erosion.

GEOLOGICAL SECTION OF NORTON CO. KAS.

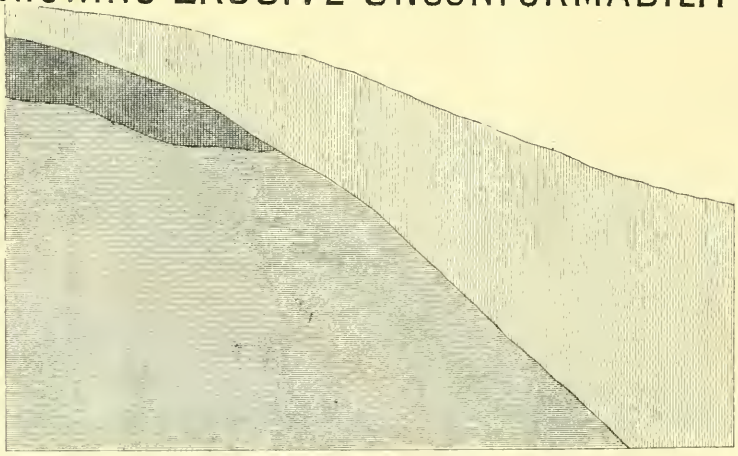


From S. to N. and N. by W. along line in Map marked A.B.C. Being an Appendix to Geological Report of the County by Robert Hay.

NOV. 1883.

MIOCENE PLIOCENE CRETACEOUS

DIAGRAM SHOWING EROSIVE UNCONFORMABILITY



MIOCENE PLIOCENE CRETACEOUS

From a Section seen in a Ravine South from Edmund.

The green sand and green shale almost entirely disappeared, the valley of the Prairie Dog was cut out about to its present depth, and a long submergence filled it all up with the irregular beds of the Miocene.

No. 6. Above the Miocene is a bed of chalky, sandy marl, which everywhere gives to the high prairie a long rolling slope. In the southeast of the county it thins off, and in high places we have a sedentary soil of the Miocene. But this sandy marl is the stratum that covers more surface area than all the others together. It is formed mainly of the detritus of cretaceous rocks plus the sand of the Miocene. It contains everywhere chalk nodules, which appear to have acquired their form from fossils which no longer fill them. In one place, south of Edmund, where this formation rests on the chalk, it seems to be a layer of it, so full is it of fragments of haploscapha and ostrea congesta. This bed is in Norton county probably nowhere more than 100 feet thick now, but its thickness as a deposit must have been much greater. It lies *erosively unconformably* on the Miocene, yellow chalk and blue shale. The evidence is manifold, that after the Miocene was laid there was a long period of upheaval and erosion, during which the valleys of the main streams, the larger creeks, and even the smaller ravines were eroded out, and after that a submergence which allowed our No. 6 to fill up again from the bed of the Prairie Dog to the highest top of the high prairie and beyond; and then another elevation of the continent started the streams nearly on the old lines, and the cutting-out has now about reached the depth it was before, but not the area—for we find this last deposit resting on one side of small ravines, while the other is an escarpment of Miocene. It forms the second bottom of the Prairie Dog, and the alluvium of the first bottom is mainly made up of its materials. It forms the second bottom of the upper Solomon. As far east as Cawker City it forms the third bottom. It lies against the *sides* of chalk bluffs whose eroded *surfaces* have their hollows filled with Miocene grit. This is the Pliocene, which has so long figured in our Kansas geological sketches and maps, in which was hidden the Miocene before described. It is probably the Equus beds of further north and west, and it may be that it is of Pleistocene age. We have found only three bones that we are confident belong to this formation, but there are others about which the probability is great. This formation makes the smooth prairie of this and other counties, and to it the buffalo grass is most strongly attached. When it is eroded, the bunches of wire-grass get a hold in sedentary soil of the Miocene and in the flints of the upper chalk. This has occurred extensively south of the Solomon, though thick masses of it still buttress the chalk bluffs of that river.

No. 7. Is alluvium. Of this we shall say little. Its area is small, as the valleys are all narrow. Besides containing buffalo and other modern remains, it sometimes gives up a fragment of turtle shell, or a bone of a mastodon, brought from the Tertiary formations. There are three northern tributaries of the Solomon, named Sand creek, because the alluvium is entirely sand, formed from the breaking-down of the Tertiary bluffs, the Miocene here being more sandy than elsewhere. In these three creeks, the water disappears below the beds of sand for spaces varying from a quarter to a whole mile.

We must now refer briefly to the dip of the strata. It is scarcely possible to recognize any dip in the Tertiary formations. We thought we could partially do so at Monk's Cañon. Of the Cretaceous strata, (including the green shale,) there were only six places where we could fairly see the dip, or rather see that there was a decided dip, for in only two or three places could we get a section at right angles to the dip. The observations at these half-dozen places gave us a little start. The dip was not in the direction we expected for Kansas. In five out of the six places it was decidedly southeast—or a little more south than east. In the blue shale on West Sand creek, we got a fine exposure, and by the courtesy of Mr. Trescott, County Surveyor, we were enabled to take observations with instruments, and measured 195 feet of length, in which we got a dip of 14

feet. That is, about 1 in 14, or an angle of 10°. This was, however, nearly due south, and we estimated that an additional 5° would be necessary for the easting. The dip at Norton Mill is probably not more than 7° or 8°.

The fact previously assumed, that the beds of the northern streams are higher than the Solomon bed, and that the chalk is shown in each, is probably due to this southeast dip. And to this dip is probably due the other potomographic fact, that the streams are on the south side of their troughs. This fact of dip may have a bearing on the question, How deep must we go for coal in western Kansas?

There are many cracks in the cretaceous strata, and a few faults. One at Norton Mill gives a displacement of about 9 inches, and one at Mr. Trescott's 6 inches. Another at the latter place gives a break of not less than 12 feet. It is the largest we have seen in Kansas. We saw no breaks in the Tertiary.

3. PALEONTOLOGY.

On this head we can add very little to the incidental remarks made in previous paragraphs. We are indebted to Professor E. D. Cope, of Philadelphia, for the names of some of the fossils we exhibit here, but those are not given positively. A specialist should examine the specimens themselves, and more than one specialist.

We wish here to be emphatic on one point. We desire a good museum of Kansas specimens in Topeka. It is the capital of the State. Many persons will visit a collection here who will never see those at our State educational institutions. We wish the Kansas Academy of Science to make a State museum at the State capital. We succeeded in infusing this idea into our friend, Doctor Turner, who therefore gives up to us the fine chelonian specimen before us. He and I together have also preëmpted the side of a ravine, which has yielded the rhinoceros jaws, the tusk, and other fossils without number, the front of one of our excavations measuring 10 metres. Two other places we have actually proved to be rich in remains, one yielding these mastodon bones, and the other this large rib and fragment of tooth. Another place still, I have good evidence, will pay well in Miocene remains for any labor put upon it. All this in one county; and there are many counties in Kansas, and other formations besides Niobrara and Tertiary. We will enumerate the kinds represented by the Miocene fossils:

Mastodon, Brontotherium, Oreodon, Rhinoceros (Aphelops), Horse, and Tortoise of at least three species. The one in the photograph is Xenobatis. It is certain that continued excavations in more than one of the places already worked would yield almost complete skeletons. It is probable that no finer set of teeth has never been obtained than are in this jaw of a young rhinoceros. There are also fossils from this region in private hands, that can be procured if proper effort is made.

4. ECONOMIC GEOLOGY.

The useful value of the minerals of this county is great. In several places in the county, the chalk is sufficiently compact to be used for building, and is sawed into blocks for that purpose. Still more plentiful is hard, durable stone from the Miocene ledges, the jail at Norton being built of such blocks as the one before us. The soil of the county is probably as rich as that of any part of the State, containing both lime and silica. The Pliocene beds may be considered good soil to their entire depth, though lacking in organic matter. The abundant rains this fall have given sufficient illustration of the fertility of all the various soils.

The supply of water is directly connected with the condition and position of the strata. At Miller's Spring we have noticed that water comes off the shale. This is the case also on Ghost creek, while at Silver creek, a little further east, the water comes off the chalk. On the high prairie, the wells are deep, needing to reach to the bottom, or nearly to the bottom, of the Miocene grit which appears to be the chief reservoir. A proper survey which would note both dip of strata and elevation of surface would, we believe,

indicate that artesian wells would be possible and profitable in several of the northwestern counties. Where the Miocene is much cut by ravines, there is not sufficient area to store water for springs or wells. In the river bottoms, some wells are very deep, and have their reservoirs in a sand which appears to be the alluvium of the period, when the Miocene was first eroded.

As in all the Northwest, there is a general anxiety in this county about coal. At two places in the Solomon valley it is reported that small quantities of coal have been taken which burnt well; but these were not seams, but pockets in the blue shale, and were speedily exhausted. It would be interesting, had it been noted, whether this carbonaceous matter was of vegetable or animal origin, as some animal remains of the Niobrara have a lignitic appearance. The black streak in the green shale may be an indication that it belongs to the lignitic formation, but it goes without saying that the blue shale is not an indication of coal. What effect on the depth to the true coal the direction of the dip before noted may have, can only be determined by more extended investigation going over several counties. If coal be really continuous under the whole State, as it would appear that the coal measures certainly are, and if it should be shown that the northwesterly dip we have been familiar with gives place over any large area to a southeasterly dip, it would not be improbable that coal might be found in the region of the one-hundredth meridian at depths not exceeding those of the deep pits of England, or about three times the depth of the Leavenworth shafts.

There is very little stone which yields good lime when burnt. The native lime, as we have seen, is largely developed, and is of considerable utility. Of sand there is an unlimited supply. Of other minerals, crystals of calcite are most abundant in the forms occasionally of dog-tooth and nail-head spar. This is associated often with baryta, but only sufficiently to give weight and slight color to the specimens, and there is some strontium. Mostly calcite is found in the cracks of the Niobrara formations, but some large specimens, obtained south of Edmund, it appeared had been formed in the hollow of a large haploscapha. Silicates in the form of moss agate (often very imperfect) and jasper are common in the chalk, and there are some quartz crystals in nodules and cracks. Among the pebbles of the Miocene conglomerate, there is rose quartz, jasper, agate, calcedony, diorite, feldspar, and granite (rare). Fine specimens of dendritic manganese are not uncommon both in stone and bone. Some miles east of Norton there is a deposit of many acres in extent, and over four feet thick, which is very fine grained and has fine polishing qualities. It has been called emery, and it seemed to have some properties of corundum, but Prof. Failyer says it is fine silicious sand. We ask, is it an infusorial bed akin to that in the Miocene of Virginia? Will some microscopist of the Academy answer this, and if the answer is affirmative, describe its diatoms and polycystines? We found traces of the bed at one point many miles distant, and heard of it at another. It is apparently of Miocene age.

In conclusion, we wish to give credit and thanks for invaluable assistance to our friend E. M. Turner, M. D., of Norton, without whose enthusiastic aid it would have been impossible to obtain such definite results in so short a time and at so small an expense. To County Clerk Harmonson and Surveyor Trescott are also due thanks for help cheerfully rendered, and other citizens who sought to facilitate our object. The Missouri Pacific Railway officials readily gave information with regard to the elevations obtained by their surveyors, and the Union Pacific Railway gave passes, which, though arriving late, were and will be of some service.

Finally, a large part of the value of this report is due to the encouragement given to the writer by our late and present President, who guaranteed the expenses, and to whom are due the writer's personal obligations and the heartiest appreciation of the Academy.

NOTE.—The silicious sand from the Miocene was somewhat hastily examined with a microscope by Professor Cragin, during the meeting of the Academy, who reported that it did contain diatoms. A

further examination shows that it is much finer than the Infusorial earth of Virginia, and the microscopic remains are all greatly comminuted.

NOTE 2.—A fine fossil obtained from the Equus Beds (Pliocene) has been pronounced by Prof. Cope to be *Bison*. It is the right mandibular ramus, with six teeth, two teeth being much worn.

APPENDIX A.

Dimensions of fossil tortoise from the Loup Fork Miocene of Norton county, referred to in the preceding report. (Xerobatis [cyclopygius?] Cope,) found by Dr. E. M. Turner, four miles southeast of Norton:

	M.
1. Length of carapace along median line	.37
2. Length of carapace, following curve	.45
3. Breadth of carapace	.30
4. Breadth of carapace, following curve	.47
5. Internal height from line used in No. 1	.11
6. Internal height from line used in No. 3	.14
7. External height plastron and carapace	.21
8. Length of plastron on median line	.32
9. Extreme length of plastron	.34

The shell of the carapace very thin and delicate, in places has less thickness than .005.

Dimensions of rhinoceros lower jaw; Aphelops (Fossiger?) found, with other parts, four miles southwest of Norton, in the Loup Fork Miocene:

	M.
Length of jaw from the sockets of the incisors, along the line of surface of the teeth, to the back of the jaw	.44
Height of jaw	.37
Length of line of teeth	.21
Length of line from front of jaw to first tooth	.07
Length of line from last tooth to back of jaw	.16
Depth of jaw below premolar	.08
Breadth of the jaw at symphasis	.08
Breadth of the jaw at furthest teeth	.24

The last dimension is probably .03 or .04 less than the natural width, as the jaw is slightly compressed and distorted.

All these dimensions were taken before attempting to move the specimen, or covering it with plaster necessary to preserve its form.

APPENDIX B.

Elevations supplied by officials of the Central Branch Missouri Pacific Railway:

	Feet.
Atchison, elevation above tidewater	814
Netawaka	1,119
Blue Rapids	1,208
Greenleaf	1,435
Washington	1,329
Clyde	1,318
Concordia	1,392
Beloit	1,402
Cawker	1,510
Kirwin	1,720
Logan	1,912
Edmund	2,144
Lenora	2,290

APPENDIX C—Map of county.

APPENDIX D—Section across county.

APPENDIX E—Diagram of Erosive Unconformable.

OCTAHEDRAL LIMONITE.

BY ERASMUS HAWORTH.

I wish to call attention to a very interesting change now in process in the composition of certain iron pyrites crystals in Dickinson county, Kansas.

In the fall of 1880 I received a number of very perfect octahedral crystals from this county. They were small, their axes varying from one to three-eighths of an inch in length; were of a brown color; and a number of them were hard enough to scratch glass. Remembering that Professor Mudge had reported Spinel from Riley county, I at once concluded these were crystals of the black variety of Spinel, *Pleonaste*, which contains from eight to twenty per cent. of iron oxide. During the winter of 1882, Professor Patrick wrote me that he had examined some of them, and found nothing but iron oxide and traces of water, and suggested the probability of their being altered pyrite. I had no occasion to examine them further until within the last few weeks. On careful examination, it was found that the interior of many of them was unchanged iron pyrites, while the exterior was a hydrated iron oxide.

Through the kindness of Mr. Winnie Sterling, of Midway, Dickinson county, Kansas, I was furnished a much larger assortment of specimens. In this lot I found many crystals which were entirely free from indications of decomposition. Between this and the other extreme, in which there is no trace of sulphur, there is a regular gradation; so there can be no doubt as to the origin of the iron-oxide crystals.

Now the one interesting fact is, that we have here a complete change from the bisulphide of iron—pyrite—to the hydrated oxide of iron—limonite—without altering either the size or form of the crystal. The decomposition of pyrite is an every-day occurrence, familiar to all; but the usual process is to oxidize one-half of the sulphur to the common sulphurous acid gas, while the remaining sulphur, with the iron, is oxidized to ferrous sulphate—*copperas*—which is dissolved by percolating waters. Here, however, we have the whole of the sulphur, removed atom by atom, and its place snugly filled by oxygen and traces of water.

This is the only instance of which I have any knowledge of limonite occurring in octahedral crystals; in fact, it is quite unusual to find it even approaching a crystalline form. It frequently occurs with a smooth botryoidal surface and an internal fibrous structure; but in the case before us, so far as observed, there is no approach to a fibrous structure.

Mr. Sterling writes that he found the specimens near Midway, Dickinson county; that the brown ones—that is the ones partly or wholly decomposed—were found on the surface; that those which were undecomposed were found about two feet below the surface, in a black shale.

PENN COLLEGE, IOWA, November, 1883.

NOTE ON A NEW KANSAS MINERAL.

BY J. T. WILLARD.

Last summer, Mr. J. B. Stevenson, of Garrison, Riley county, sent a mineral to the laboratory of the Agricultural College for identification. It was at first supposed to be hematite, but the black streak obtained on powdering it showed that this surmise was incorrect. A more careful examination proved it to be menaccanite, or titanic iron ore. It occurs in irregular grains of an iron-black color, and submetallic luster. Its fracture is conchoidal, and on the broken surfaces it exhibits a peculiar luster, resembling that of

asphaltum. Its hardness is between five and six, but it is quite brittle. Its specific gravity is 4.494. It acts slightly on the astatic needle, but is not attracted by the magnet, even when finely powdered. It does not become magnetic on ignition. Difficultly soluble in hydrochloric acid.

Menaccanite is hematite in which part of the iron has been replaced by titanium. Frequently an additional quantity of the iron is replaced by other elements. The amount of iron thus replaced is by no means constant, and hence we have a number of varieties of this mineral, which can be distinguished only by a chemical analysis. With a view to ascertaining the composition of the subject of our note, the writer made an analysis of it.

About two grams of the mineral, reduced to an impalpable powder, were dissolved by a mixture of strong hydrochloric and hydrofluoric acids. This method of solution is much more rapid than by the tedious process of fusion with potassium bi-sulphate, or other fluxes. After complete decomposition of the ore, the hydrofluoric acid must be entirely expelled by heating with pure sulphuric acid. The solution is then made up to a definite quantity. If the heating has caused a partial precipitation of the titanic oxide, it may be brought into solution by fusion with potassium bi-sulphate. The iron, aluminum and titanium, in one-fifth of the solution, were separated and determined by the familiar methods. From the remaining four-fifths of the solution, all the bases, excepting magnesium, calcium and manganese, were separated by means of sodium acetate. From the concentrated filtrate, the manganese was removed by bromine, and calcium and magnesium determined in the usual manner. The result of the analysis is as follows:

Titanic oxide, TiO_2	47.905	per cent.
Ferrous oxide, FeO	34.755	" "
Magnesium oxide, MgO	9.714	" "
Aluminum oxide, Al_2O_3	6.462	" "
Manganous oxide, MnO	1,897	" "
Calcium oxide, CaO	.084	" "
Total	100.817	per cent.

This composition does not correspond with that of any of the varieties given in Dana's Mineralogy, but seems to be near magnesian menaccanite. Efforts to obtain details in regard to the occurrence of our specimens have thus far been unsuccessful. The mineral is of no commercial value, and is interesting chiefly because of the fact that it contains titanium, one of the rarer elements.

BIRDS NEW TO THE FAUNA OF KANSAS, AND BIRDS RARE IN THE STATE.

Captured at Wallace, Kansas, October 12 to 16, 1883.

BY N. S. GOSS, TOPEKA.

Merula migratoria propinqua Ridgw. Western Robin. Saw a flock of seven; killed two.

Zonotrichia gambeli intermedia Ridgw. Intermediate White-Crowned Sparrow. The birds were quite common along the railway, in the ditches and cuts, which afford both food and shelter from the weeds growing and blown in from the plains. Shot several. Prof. D. E. Lantz writes me that he killed one of the birds at Manhattan, October 9, 1883. The Professor is therefore entitled to the credit of adding the birds to our State list. Its capture so far east is a rare find.

Sphyrapicus varius nuchalis Baird. Red-Naped Woodpecker. Killed a pair out of

three young birds found in the willows and cottonwoods thinly skirting the South Fork of the Smoky Hill river.

Buteo borealis krideri Hoopes. Krider's Hawk. Killed a female; think I saw another bird, but am not positive, as they so closely resemble at a distance the light phase of *Archibuteo ferrugineus*.

"BIRDS RARE IN THE STATE."

Myiadestes townsendi (Aud.) Caban. Townsend's Solitaire. Saw ten; shot four of the birds.

Dendroeca audubori (Towns.) Baird. Audubon's Warbler. Shot several; quite common.

Corvus cryptoleucus Couch. White-Necked Raven. Saw a flock of six and one of seven birds; shot three.

I have specimens of the above birds in my collection.

I rejoice to know that we are at last to have a standard classification and nomenclature, as it will in the future do away with the present confusion in arrangements and of names. I shall, in accordance with same, issue a new edition of my Catalogue of the Birds of Kansas.

A CLASS-ROOM EXPERIMENT ON EBULLITION.

BY EDWARD L. NICHOLS, PH. D., OF THE STATE UNIVERSITY.

The change of volume of water between 0° and the boiling-point has been very carefully studied. It is most conveniently expressed by means of the well-known curve, in which the abcisse are temperatures, and ordinates represent the volumes. Beyond the boiling-point, however, the curve varies with the conditions of the experiment. If boiling takes place without superheating, the change of volume of the liquid and vapor is represented by a vertical line; but if the water be superheated before ebullition occurs, the curve takes a form not yet fully determined.*

Of the behavior of a superheated liquid we know but little aside from the fact shown in Dufour's† and in Donny's‡ well-known experiments, that the temperature may be raised many degrees above the normal boiling-point without ebullition. Those experimenters have shown, what indeed we should expect from the nature of the process of ebullition,§ that in order to prevent boiling it is necessary to have expelled all gases from the body of the liquid. In Dufour's experiment this condition is attained by suspending a globule of previously boiled water in a mixture of olive oil and the oil of cloves, the proportions being such as to give a density to the mixture just equal to that of water. In this way water has been heated to 178° without boiling; and when ebullition does take place the tension of the vapor is sufficient to produce a considerable explosion, sometimes blowing the hot oil from the bath with violence. Donny's method of excluding the air consists in boiling the water in one end of a long and doubly-bent tube; after which, without stopping the ebullition, the other end is sealed in the blast-lamp. In such a tube water may be heated to about 130°, at which temperature explosive boiling takes place, and the tube is generally shattered.

For the purpose of illustrating this interesting phenomenon to his classes, the writer has made use of the following very simple device. In a small "U" tube with unequal

*Upon this point see James Thomson—Proceedings of British Association, 1871; also, Maxwell's Theory of Heat.

†Bibliothèque Universelle—Archives, 1861, vol. XII.

‡Annales de Chimie, 3d series, vol. XVI, 1871.

§E. L. Nichols—Proceedings of the American Association, 1881; also, Maxwell's Theory of Heat.

arms, the shorter arm of which is sealed, a small quantity of water is placed. A column of mercury is introduced next, to separate the water from the outer air, this column being of such length as to bring the water under a total pressure of a few millimeters less than one atmosphere. If the tube thus filled be placed in a bath of boiling water, the water within the tube will boil, and the mercury will be driven outward until it stands at the same height in both arms of the tube, or until the vapor formed has reached its maximum tension. At the same time a small bubble of air will be excluded from the boiling water, which upon cooling can be removed from the tube. If this process of boiling, cooling, and expelling the excluded bubble of air, be repeated until on further boiling no bubble is formed, the water will finally refuse to boil when the tube is placed in the water bath; and in the oil or paraffine bath it can be heated to 130°, as in Donny's experiment, without ebullition. At this temperature vapor is suddenly formed, and the mercury is violently expelled from the tube.* The apparatus then only needs refilling to be ready for a repetition of the experiment.

The writer hopes, with the aid of this very simple apparatus, to make a more detailed study of the superheating of various liquids, and of the attendant phenomena, than has been possible hitherto.

THE UTILIZATION OF MINERAL WATERS.

BY E. H. S. BAILEY.

There has been for the past few years a growing interest in the subject of the purity of water supply. Whether for municipal supply, for boiler purposes, for use in manufactories, or for domestic use, people begin to realize that certain constituents are dangerous, others of no use, and others detrimental. It is difficult to draw the line sharply between potable waters and so-called mineral waters. If we attempt to put a maximum limit to the solid residue that a potable water shall contain, there are numerous mineral waters, acknowledged to be of value, that do not contain a tenth the amount. Again, very hard waters are often richer in mineral constituents than the so-called mineral waters. A mineral water, then, may be defined as one containing an abnormal amount of solids, or containing some unusual constituents. Chalybeate, Borax and Lithia springs belong to the latter class. It often occurs that waters, like those of many of the Saratoga springs, contain 800 to 1,000 grains of solid matter per gallon, and also comparatively rare elements, such as Bromine, Iodine, and Lithia.

Water, the great solvent, has taken into solution — has selected, so to speak, from the variety of material through which it has flowed — certain substances. Though we may make artificial mixtures closely resembling the natural, it is found difficult to exactly imitate nature. An interesting case was up for consideration a year or two ago in the United States Department of Customs. It seems that natural waters are admitted free of duty, while artificial waters are taxed. The Apollinaris Company were anxious to import duty-free; but it was shown by chemical experts that the spring water was salted and surcharged with carbonic acid gas before being bottled, and so became an artificial water. The Secretary of the Treasury, however, overruled the opinion of these experts, and of the Attorney General, and all duties were remitted, much to the disgust of those engaged in bottling American spring waters.

*The apparatus here described is given in some text-books on physics (see Dechanel's Natural Philosophy, part II), its object being to illustrate the tension of vapor formed when a liquid boils under atmospheric pressure. The behavior of the liquid when all air is expelled, as above described, seems not to have been observed.

As the State of Kansas is being developed, new mineral waters are being reported. Springs are discovered, or artesian wells are sunk, often yielding an abundant supply.

Naturally, the attention of the medical profession is called to these as possible curative agents, and we have reason to believe that as valuable waters may be found here as in neighboring States. But not only from a medicinal point of view may it be possible to utilize these waters. The industry of salt making already occupies a prominent position in some sections of the State, and only awaits more capital and the discovery of stronger brines to become of increased importance. We do not know to what extent beds of salt underlie the later rocks of the State. That it may become an important industry here may be gathered from the fact that in the vicinity of Syracuse, N. Y., over 9,000,000 bushels of salt are manufactured in a single season. There is certainly a home market for a large quantity of this material.

In some sections of the country mineral waters are utilized for the manufacture of Borax, of Bromine, and Iodine, and who shall say that even such rare elements as Lithium may not be found in paying quantities? It is well to remember that many substances now counted rare and of little value need but to be cheaply obtained to attain commercial importance.

While it is still a question whether the State has any extensive mineral deposits, and while we cannot boast of pure soft water, it may be possible in many other ways than these that have been briefly suggested, to utilize what we have, and thus aid in developing our latent resources.

ON THE COMPOSITION OF SOME CULINARY UTENSILS.

BY E. H. S. BAILEY.

Much attention is being paid in this country, and still more abroad, to the subject of food adulteration. Under the supervision of boards of health, elaborate examinations of food products are made, and careful tests are executed for suspected adulterations and falsifications. In the United States, some of the more populous States have enacted laws, and created boards for the special purpose of protecting the people against intentional fraud, and criminal carelessness. It is largely the province of the chemist and the microscopist to conduct these examinations. As our population increases, there is more and more temptation to fraud in this direction, so that ultimately all States must protect their citizens.

It often happens that the food itself is of good quality, but becomes poisoned by contact with the vessel in which it is cooked. This leads us naturally to direct attention to cooking utensils and their composition. It is generally conceded that iron and tin can be used for many purposes with perfect impunity. There are, however, cheap grades of tin plate that contain a noticeable quantity of lead. M. Fordos, (Contes Rendue, 79, No. 12,) cites the results of a series of experiments on such ware. Acetic acid, (1 per cent.,) red wine and lemonade, all contained lead after standing in the vessels for some time. Copper and brass can, with a reasonable amount of cleanliness, be used for many purposes, but should never be employed for heating any acid liquids. It is true that many housewives still recommend heating vinegar for pickles in a copper or brass kettle, because, forsooth, it gives them a "natural green" color. They have yet to learn that the copper compound thus formed is a dangerous poison, even if present in small proportions only. The writer had occasion to examine a green pickle for copper, and found $\frac{1}{25}$ of a grain of the metal, equal to $\frac{1}{7}$ of a grain of blue vitriol, in a pickled cucumber weighing a little over two ounces.

Cooking utensils, made of a soft and porous variety of earthenware, are much used

in some localities. This ware is covered with a glaze consisting essentially of silicate of lead. From carelessness in manufacture, the composition is by no means uniform.

I have instituted a series of experiments to determine, if possible, whether any danger could result from the use of these vessels in cooking.

I. About a pint of pure water was boiled in a clean, old earthenware vessel for 1½ hours, and no trace of lead was found in the water.

II. An equal quantity of vinegar (containing 33 per cent. of acetic acid) was boiled for some time in the same vessel, and from this solution .77 grains of oxide of lead, equivalent to 1.12 grains of sugar of lead, was obtained.

III. A 20-per-cent. sugar solution was heated for three hours in an old earthen vessel, and upon testing gave no lead.

IV. Apple sauce was heated for about twenty-four hours in an old vessel. This showed but a slight trace of lead.

V. Milk was allowed to stand for several days in an old vessel, and afterwards heated. Although thoroughly soured, it gave no evidence of containing lead.

VI. Experiments made with boiling water in a *new vessel* gave no lead.

VII. An experiment made with vinegar, heated for several hours in a new vessel, showed the presence of .25 grain of PbO, equal to .37 grain of sugar of lead.

VIII. A test made upon apple sauce heated in a new vessel gave no indication of lead.

IX. Lard was heated for twenty-four hours in a new vessel, and in this only the *slightest* trace of lead was to be detected.

From the above experiments I conclude that acid solutions should neither be heated nor allowed to stand in these vessels. When the vessel is old and the glazing becomes cracked, there is greater danger of lead poisoning consequent upon its use than in the case of a new vessel. It is always safer to thoroughly cleanse the new vessel before using, by washing with vinegar and water.

A class of ware known as granite ware, or marbleized ware, has come into the market within a few years. This glaze, which is usually on sheet iron, generally consists of an insoluble silicate of a non-poisonous metal. Dr. Zinrek, of Berlin, has however analyzed the enamel of a stew-pan, which contained so much lead that 2¼ grains of oxide of lead was found in a liter of vinegar which had been boiled in it for an hour. The author has found one specimen of glaze that contained a notable per cent. of zinc. Glazes of this class can however be made of such material that they may be used with perfect impunity. The whole subject is one deserving careful and unprejudiced consideration.

ARCHÆOLOGICAL NOTES.

BY GEO. S. CHASE, TOPEKA.

During the summer of 1880, the writer, while traveling through the mountain region north of Santa Fé, New Mexico, stopped over night at the village of Taos, near the ancient pueblo of Taos, at the base of the western slope of the Sangre de Christo range. Here he met an old schoolmate, who had been trading at the place for several years. The day before our arrival, a Pueblo Indian had stolen from the priest at the pueblo what he declared to be a greatly-revered god of the village, and offered it in trade for that greatest of evil tempters, the white man's firewater. Prompted by curiosity, my friend supplied the commodity demanded in exchange, and took possession of the god. Seeing that the article awakened my interest, he at once presented the deity to me, and upon the following morning I departed with it in my possession.

Some time later I passed through Taos again, on my return trip, and my friend in-

FIGURE 2.
SIDE VIEW.

FIGURE 1.
FRONT VIEW.

formed me that the day after I left, a delegation from the pueblo, with their priest, had waited upon him for the purpose of ransoming their lost god. It seemed that it had been missed almost as soon as taken, and that the thief, as soon as his spree was over, had become anxious on account of his conduct, and confessed his guilt, and directed them where to find their missing deity. When they were told it had been carried away by a stranger into a strange land, they expressed extreme regret, and appeared to be greatly affected over their loss.

The image is worked out of dark-green quartz syenite. The Pueblos, from whom it was obtained, did not make it, nor had they any knowledge or notion as to its origin, so far as I could learn. They only knew that it had passed down from one to another for many generations, and that for a long time it had had a place in their local traditions as a thing to be revered. I do not wish to be understood as placing any especial importance upon the place that this object occupied in the Pueblo village. I do not know that they have a well-defined system of idol worship. Their original traditions and forms of worship have become so peculiarly mixed and amalgamated with a degenerate and renegade Catholicism, that it is difficult to determine how much is one and how much the other. This much, however, is certain: they are filled with superstition, and prone to worship, more in fear than from any other incentive, any object or natural phenomenon that appears to them strange or unnatural. The object to which this brief paper refers is the work of another and an earlier people, from whose mysterious, disputed, "half concealed and half revealed" existence this little image derives its interest. I presume it was found by some of these Indians, perhaps many centuries ago. Its appearance was such as to awaken their curiosity, and not being able to account for its occurrence, and not knowing what should be done with such a looking thing, the natural propensity — not yet wholly extinct in the human species — to be on the safe side, prompted them to assign to ita niche in their fantastic hierarchy.

OBSERVATIONS OF THE BREEDING HABITS OF THE AMERICAN EARED GREBES.

(*Dytes nigricollis californicus.*)

BY N. S. GOSS.

June 4th, 1877, I had the pleasure of finding about one hundred pairs of the birds nesting in a little cove of Como Lake, a small alkali lake without outlet, in the Territory of Wyoming, on the line of the Union Pacific Railway — altitude 6,680 feet — nests in a narrow strip of rushes growing in water eighteen inches deep, and about one hundred and thirty feet from the shore; between the rushes and the shore a heavy growth of coarse, wide marsh grass, the whole not covering over from one to one and one-half acres. The bank being a little higher than the ground back, the approach was unobserved, and my appearance so unexpected and near gave the birds no time to cover their eggs as is their wont, giving me a fine opportunity, on wading out, to see the eggs in their nests. I collected the eggs from two nests, five in each, and counted from where I stood over twenty nests with from one to five eggs, quite a number completed, but without eggs, and others building; nests floating, made of old or broken rushes, weeds, and debris from the bottom and partially filled in and around the standing, growing rushes — no feathers or lining of any kind; from five to ten inches in diameter; the outer edge

or rim from two to three inches above the water; eggs in several touched the water, and were more or less stained in their wet beds; color of eggs when fresh, white, with a light bluish shade; average measurement of the ten eggs, $1\frac{80}{100}$ by $1\frac{20}{100}$ inches. I watched the birds closely, during the three days I remained. Those out upon the lake were noisy and active, keeping near the center and closely together. It was their courtship and mating-ground, but the birds in going to and from their nesting-places were silent and watchful. In leaving their nests, would dive off, come up quite a distance away, and then swim rapidly for the flock in the lake. I noticed at all times, not far from the breeding-grounds, from five to eight birds, evidently sentinels, sitting upon the water with heads high, ever upon the lookout and ready to give the alarm, but slow to leave their station — in fact never leaving the little bay, taking good care, however, to keep out of reach. As soon as I passed by, the birds frightened from their nests would cautiously but quickly return, join the sentinels, from which point they would dive and come up among the rushes. In no instance did I see them swim to or from their nests; they may, however, do so when not disturbed.

As papers of this character are written solely to present the observations and views of the different writers, in order that in the end its history may be known and correctly given, I will say that Mr. H. W. Henshaw, in paper of like character (Am. Nat., VIII, 1874, 243), found the birds nesting in similar lakes and places in southern Colorado, but I think him somewhat in error in the conclusions reached, from the following portion of his observations, viz.:

"The eggs were wholly concealed from view by a pile of weeds and other vegetable material laid across. That they were thus carefully covered, merely for concealment, I cannot think, since in the isolated position in which these nests are usually found, the bird has no enemy against which such precautions would avail. On first approaching the locality, the grebes were all congregated at the further end of the pond, and shortly betook themselves through an opening to the neighboring slough; nor, so far as I could ascertain, did they again approach the nests during my stay of three days. Is it not then possible that they are more or less dependent for the hatching of their eggs upon the artificial heat induced by the decaying vegetable substances of which the nests are wholly composed?"

Surely the birds *have* enemies in the vicinity, especially in the hawks and gulls, that would quickly notice the eggs if uncovered. In the grass, not fifty feet from the nests I have described, a marsh hawk (*Circus hudsonius*) was found sitting upon five eggs. I also noticed several hawks in the vicinity, and several ring-billed gulls (*Larus delawarensis*) were skimming over and about the lake. Further, I do not think it "possible" to create artificial heat from the slow decay of the vegetable matter composing the nests, resting as they do in and upon ice-cold water, the eggs often touching the same. Before wading out to the nests, I removed my boots and socks, and during the short time I was in the water my feet and limbs were painfully cold. Colorado lies farther south, and the elevation not so great, but the waters are made largely from the melting snows, and must be chilly and cold so early in the season. I am inclined to think rather, that at the time the birds were first discovered, the males, and hen birds not mated, or laying, were near their nesting-grounds, and that those on their nests, after covering their eggs, dived off, came up in the flock, and swam away with them, returning one by one when the cause for alarm was removed. By swimming under water with only bill out at times to breathe (a habit of the birds well known), they could easily reach their nests unnoticed. Or it may be, as Mr. Henshaw only found three eggs in the nest — four to five being a full set — that none of the birds were sitting. In this case there would be no necessity for a hurried return, as absence during the day would do no harm.

NOTES ON THE NESTING HABITS OF THE YELLOW-THROATED VIREO.

(*Lanivireo flavifrons.*)

BY N. S. GOSS.

On the 9th of May, 1877, I found in the timber near Neosho Falls, Kansas, a nest of the birds (a pendent one, as all the vireos' nests I have found are), attached to branches of a very small horizontal limb of a large hickory tree, about twenty feet from the ground and ten feet below the limbs that formed the tree-top. In the forks of the tree the Cooper hawks were nesting, and I discovered the bird and the nest in watching the hawks — or rather, the man I had hired to climb the tree to the hawk's nest. The little bird at first flew off, but on his near approach, returned and suffered him to bend the limb towards the tree and cover her with his hand on the nest. The twig was quickly broken, and the bird and nest lowered by a line in a small covered basket taken to collect the eggs of the hawks. Such manifestations of courage and love, so rare and exceptional, touched me to the heart, and it was hard to make up my mind to rob and kill the bird and her mate scolding in the tree-top. I can only offer in extenuation that they were the first I had met with in the State, and the desire *strong* to have them in my collection. The nest was made of and fastened to the limb with silk-like threads, and bits of cotton from plants, fastened together by saliva and partially covered or dotted over with lichen, and lined with small stems of weeds and grass; a beautiful nest, in plain sight — nothing near to cover or hide it from view. There were three eggs, also one egg of the cow blackbird (*Molothus ater*); one of the eggs was broken by the bird in her struggle to free herself from grasp while in nest. Color, pure white, with a few scattering small spots toward the large end, of reddish brown. Measurement of each, .79x.58 of an inch. Of four taken from a nest (a full set), .78x.57, .80x.58, .79x.58, 78x.57.

I have since noticed the birds in the woodlands on several occasions, and on the 18th of May, 1883, while strolling along the south bank of the Kansas river near Topeka in the timber skirting the stream, I had the pleasure to find a pair of the birds building a nest in a honey locust, about sixteen feet from the ground and eight feet from the body of the tree; the nest was fastened to forks of a small horizontal branch from a main limb. The frame of the nest appeared to be completed; the birds, busy at work, the female lining the nest with small, hair-like stems, the male covering the outside with soft, lint-like fibrous strippings from plants, closely resembling the limb and its surroundings, and dotting it over with lichen — so happy in the thought that he was not only beautifying the home of his lady bird, but protecting her by his artistic skill from the casual gaze of others. Notwithstanding the fact that she had selected an open and exposed position, he could not refrain from expressing his joy at intervals during the work, in snatches of his sweetest notes. The female, more watchful, sighted me and gave notice of the intrusion. Quick as thought, the birds were away. The male, alighting near the top of an adjoining tree, at once poured forth his song in loudest notes, no doubt thinking by attracting my attention to him I would lose sight of the nest. Knowing it was too late for concealment, and that any attempt would only increase their suspicions and stop or delay the work, I carelessly walked nearer, in order to have a better view, and laid down on my back in an open space. In a short time the female returned, hopped about in the tree, inspected me closely from the lower limbs, flew away and returned several times before bringing material or venturing to the nest; but the moment she did so, his song was hushed and the work actively resumed. As the female stood upon the top of the nest with her head down and inside, I could not see the manner of ar-

ranging the lining, but as she kept walking around upon the rim, I could, in imagination, see her plaiting and weaving in and out the hair-like stems. But it was very easy and curious to see and note the actions of the male, in deftly working the material into the frame, running the longer fibrous, threadlike strippings through, quickly springing upon the top and fastening the same on the inside, then rearranging the outside, stopping a moment to inspect the work, then off in search of more material, occasionally warbling a few notes on the way, but silent at the nest, while I remained so near. At the rate their work was progressing, I think the nest would be completed during the day. I do not know that it is the usual custom for the females to confine their labors to the plain and necessary work, and the males to the decoration of and ornamental parts, but it was so in this case. It may be that the time of laying was near at hand, and that she felt the pressing necessity for the completion of its lining; for in such cases I have seen nests of birds enlarged and completed by the males while the mothers were sitting upon their treasures.

ON THE DISTRIBUTION OF SACCHARINE SUBSTANCES IN THE STEM OF SORGHUM VULGARE.

BY G. H. FAILYER.

During the course of some investigations upon the content and development of saccharine matters in the common sorghum, I made as full examination as opportunity would permit of the distribution of these substances in the plant. Any previous researches in this direction, to which I have had access, have been conducted upon the assumption that the only variation in the composition of the juice from different portions of the stem are to be accounted for by differences in age and ripeness.

Since the lower and riper joints of the southern sugar cane contain a maximum of sucrose and a minimum of dextrose, analogous results were to have been expected with sorghum. This conclusion has been only partially verified by analysis. In all earlier inquiries, the lower half of the stalk has been compared with the upper half.

While it has been found that there is a slight difference in the composition of the juice from these portions, it has been so very unimportant that Prof. Collier remarks: "There is practically no difference in the juice from the upper or the lower half of the fully-matured sorghum stalks."

It occurred to me that there might be other variations than those observed, or than would be anticipated, from differences in maturity. Accordingly, a series of analyses of the juice of the several joints of the sorghum stem were made. This analysis was necessarily confined to the determination of sucrose and dextrose. Eight stalks, similar as to number of joints, ripeness and growth were selected for each analysis, the lowest joint being in all cases rejected. The stalks were cut through each joint, and the internodes numbered from the butt. They were weighed, the juice expressed and analyzed. The sucrose was determined by the Soliel-Scheibler saccharimeter, after defecation with the smallest possible quantity of the basic acetate of lead. The dextrose was determined by Sohxlet's modification of Fehling's method.

The following table, giving the results of these analyses, shows that there is great lack of uniformity in the composition of the juice of this plant, even after it has ripened, and is in a state of comparative inactivity:

TABLE showing the sucrose and glucose in the successive joints of the Early Amber cane. The joints are numbered from the bottom.

No. of joint.....	AUG. 31, 1883.—SEED IN MILKY DOUGH.					SEPT. 3, 1883.—SEED IN DOUGH.				
	Weight, in pounds.	*Per cent. of juice.*	*Specific gravity.*	*Per cent. of sucrose.*	*Per cent. of glucose.*	*Weight, in pounds.*	*Per cent. of juice.*	*Specific gravity.*	*Per cent. of sucrose.*	*Per ct. of glucose.*
1	.955	36.2	1.056	9.43	2.13	.866	43.0	1.055	8.72	3.34
2	.902	42.0	1.060	10.52	1.65?	.862	45.8	1.059	10.31	2.59
3	1.123	51.7	1.062	10.88	2.02	.933	51.6	1.059	10.53	2.36
4	1.373	54.8	1.062	11.10	1.93	1.214	54.7	1.062	10.86	2.40
5	1.360	46.9	1.064	11.95	1.55	1.369	57.5	1.064	11.71	2.11
6	1.241	43.1	1.063	11.66	2.06	1.200	55.6	1.068	12.47	2.11
7	1.068	41.0	1.060	10.75	2.37	1.068	51.6	1.066	12.27	2.06
8	.801	38.2	1.059	8.59	2.60	.862	47.4	1.066	11.66	2.53
9	.....	.....	.....	.....	.....	.722	41.9	1.059	9.00	2.69
	SEPT. 11, 1883.—SEED DRY, BUT EASILY SPLIT.					SEPT. 18, 1883.—SEED SPLIT WITH DIFFICULTY.				
1	.938	44.8	1.053	8.98	2.56	1.123	43.5	1.062	10.90	1.55
2	.921	48.7	1.062	10.77	2.26	1.146	49.6	1.063	11.15	1.27
3	1.078	50.2	1.065	11.66	1.93	1.324	57.2	1.064	12.00	1.04
4	1.326	53.0	1.066	12.05	1.92	1.489	58.6	1.064	11.07?	.99
5	1.275	57.0	1.070	13.09	1.73	1.434	54.8	1.066	12.44	.89
6	1.102	57.9	1.069	12.87	1.54	1.324	54.9	1.067	12.68	.98
7	.913	49.0	1.066	12.31	1.64	1.159	48.2	1.066	12.27	.98
8	.850	50.4	1.066	11.76	1.83	1.123	48.0	1.062	11.07	1.65
9	.651	50.0	1.061	9.87	2.69	.794	38.4	1.058	9.04	2.46

It will be a subject of interesting inquiry, whether this variation in the distribution of the constituents of the sap of plants is universal; also, whether horizontal sections of the stem exhibit the same variation. The vegetable physiologist, as well as the chemist, may here find an interesting field.

In the evening, a popular lecture upon "The Ocean; its Fauna and Flora," was delivered by Dr. R. J. Brown, of Leavenworth.

PROCEEDINGS OF THE THIRD DAY,

NOVEMBER 23, 1883.

The President, Dr. Robert J. Brown, in the chair. The following papers were read:

COAL-OIL LEGISLATION.

BY H. E. SADLER.

Crude petroleum, or coal oil, consists of a great number of hydrocarbons mixed with or dissolved in each other. They group themselves commercially into three classes, distinguished by a difference in sp. gr., and in melting and boiling points. The refiner separates petroleum into "crude naphtha;" also sold as "gasoline," a mixture of liquids with boiling points ranging from 65° to 250° F.; "kerosene," with boiling points from 250 to 350; and "residuum," boiling at from 350° to 500° or more. Of these the naphtha, composing 15 per cent., is redistilled into three mixtures—"gasoline," with boiling points below 120°; refined naphtha, 120°–175°; and benzine, 175°–250°; and the residuum, amounting to 30 per cent., is reworked for paraffine wax and lubricating oil. The remaining 55 per cent., after being deodorized and perhaps decolorized by acids, &c., is sold for illuminating. The larger establishments commonly "crack" the oil, a process by which the residuum is converted into naphtha, kerosene and coke, and the petroleum so treated yields about 66 per cent. kerosene, 20 per cent. naphtha, the remainder coke and waste. The naphtha is then sold for private air-gas machines, for making oil gas or enriching coal or water gas, for gasoline stoves, extracting oils from seeds, and a constantly increasing number of uses. The demand is not sufficient as yet, however, to make it worth more than about one-fourth as much as kerosene.

As in most cases of fractional distillation, it is impossible to separate the liquids by one boiling. This necessitates a redistillation of at least the lighter portion of the kerosene and the heavier portion of the naphtha, at an increased expense.

This light oil, the by-product of kerosene manufacture, serves well many purposes, but for most of them it is greatly injured by the presence of kerosene. So, too, good kerosene is an ideal burning fluid. It gives a smokeless, white light, equal to eight sperm candles, at a trifling cost, estimated by Professor Chandler as follows:

8-candle sperm light, 42c. per pound,	57.2	mills per	hour.
" gas light, 83 per M,	7.6	"	"
" kerosene light, 25c. per gallon,	2.2	"	"
" kerosene light, 20c. per gallon,	1.7	"	"

At any temperature to which it is likely to be exposed, good kerosene does not take fire, but will extinguish a match or burning wick like water. Unlike naphtha, camphene or coal gas, it forms no explosive mixture with air; and it can contribute nothing to fire except by saturating other combustibles to increase the intensity of their burning. It may even be poured on a red-hot fire with no more danger than attends renewing the coal.

The presence of a small proportion of residuum in the kerosene injures its sale. The color is bad. It soon gums the wick and burns with a dull, yellow, smoky flame. No man can sell you such oil twice. Reputable dealers cannot sell it once. On the other hand, the presence of small quantities of naphtha makes the kerosene burn with a pure white light, rendering traces of residuum less perceptible, and it cannot be detected except by a test of the oil, or, too late, by an explosion. To the refiner, then, the question

of naphtha or none in the oil resolves itself into a question as to whether he shall leave it there to enhance the value of the whole, or, taking it out at considerable expense, throw it away and sell the remainder at a less price; for although the higher-priced oil may ultimately cause loss of property or life, it can rarely be traced home to him. Evidently the refiner, solely interested on the side of danger, is not he to whom it should be left to decide on the safety of our oil.

Two dangers arise from the presence of naphtha in kerosene. When a glass lamp falls it often breaks, and if the oil is adulterated the burning wick, instead of being extinguished, sets fire to the oil as well. This occurrence, however, is rare, and unless the flame extends to the saturated clothing also, is easily controlled. The second danger is that the naphtha evaporating into the air above shall take fire from the wick, or at the approach of some other flame, and exploding with a violence irresistible inflame and scatter broadcast the underlying oil. Such a fire it is next to impossible to fight. By determining to what temperature any oil can be raised before it will give off explosive vapors, we may judge of the liability of the greater disaster. This is called the "flash test." By learning to what further temperature it must be heated before this explosion or flashing of the rising vapor will become persistent or set fire to the surface of the oil itself, we may discover the chances of the lesser accident. This is called the "burning" or "ignition point," or, properly enough, the "fire test;" but for purposes of confusion or through ignorance, this term is variously applied by dealers to denote either the flashing point, the burning point, or the point at which the oil takes fire spontaneously, a temperature practically never reached. Further confusion arises from the fact that different apparatus in use give results varying often by 30°, so that we must know the means of testing, as well as the result, to judge of the oil. The temperature attained in storage or in lamps is commonly stated not to exceed 100 to 110° F. This, however, needs redetermination. If that be so, no oil is safe whose ignition point or flashing point is below 110°. The former is always higher than the latter, usually but by no means necessarily 10° to 30°; so that we cannot assert that oil whose ignition point is as high as 150° is certainly free from danger of explosion, but if the flashing-point be higher than the temperature in the lamp the oil is quite safe.

Inquiry among our dealers indicates that there are four grades of oil sold or quoted in our market, besides some special brands known by a trade-mark. The poorest is "Standard," warranted 115° fire test, whatever that may mean, and worth at the river about 14 cents per gallon. "150° fire test" is a straw-colored oil, worth one to two cents more. "W. W.," or "Water White," also 150° fire test, costs about 19 cents, and is often sold for "Headlight," which is also white, but 175° fire test, and costs 21 cents.

The repeated explosion of a lantern led me to examine some of the oils in use by our students. For this I chose Stoddard's apparatus, checking the results constantly by the New York State tester — a modification of the Wisconsin test — first used by the Michigan Board of Health. This gives results about equal to the average of the testers in common use. The following table shows the tests obtained:

No.	Brand.	Cost retail.	Refiners' fire test.	Flashing point.	Igniting point.
1	Standard,	20c.	115°	88.5°	105.0°
2	150 test,	25	150	86.1	101.2
3	150 test,	25	150	120.5	149.9
4	Water White,	25	150	106.2	131.7
5	Special Brand,	30	150	109.2	132.0
6	Headlight,	30	175	107.8	128.6
7	Headlight,	30	175	108.8	134.0
8	Headlight,	30	175	82.1	102.0
9	Headlight,	30	175	below 50	81.3

Of these it may be remarked that No. 2 was evidently "Standard," sold by mistake or fraud for "150 test." Nos. 6 and 7 were probably "W. W." No. 8 was a fraud, clear and white, but evidently mixed with naphtha; and No. 9, which had already occasioned several explosions, was simply gasoline, sold by mistake for "Headlight." But one of these oils exceeds the bare point of safety, though only three of the nine cost less than 30 cents, and two of the nine could only be used by making certain that neither in lamp or can could their escaping vapors come in contact with flame. Those who knowingly buy cheap oil, cannot perhaps complain; but certainly there can be no excuse for permitting manufacturers or dealers to palm off with impunity highly-dangerous mixtures on those who, willing to pay the highest price, have a right to assume that the oil is at least inexplosive at the temperature of a summer's day. Already in 1882, statutes had been passed by many governments, regulating the character and sale of burning fluids, as may be seen from the following table, taken from Mr. A. H. Elliott's excellent report upon the subject to the New York Board of Health (2d Annual Rept., 1882):

State.	*Flashing test.*	*Fire test.*
Canada,	95°	....
England,	100	....
France,	95	....
Japan,	.....	120°
Sweden,	104	....
Germany,	.....	104
Georgia,	.....	110
Illinois,	.....	150
Indiana,	120	....
Iowa,	.....	100
Kentucky,	.....	130
Louisiana,	125	....
Maine,	.....	120
Maryland,	.....	110
Massachusetts,	100	110
Michigan,	120	....
Missouri,	.....	150
New Hampshire,	.....	120
New York,	100	....
Ohio,	120	....
Pennsylvania,	.....	110
Vermont,	.....	110
Wisconsin,	.....	120
Rhode Island,	110	....

Among our own statutes is one regulating the sale of oil, framed apparently by the manufacturers to prevent action by consumers, and setting forth a fire test in such an indefinite way as to make it impossible to secure a conviction for selling any grade of oil. Besides, it imposes such onerous burdens on the complainant, that so far as I can learn no one has yet had the hardihood to avail themselves of its provisions. A bill presumably in the interests of the people fell flat in our last Legislature; another at the session before. I am well aware that the propriety of such legislation may be called in question. I yield to none in confidence that for our country at least the doctrine of "*lassez faire*" is the only safe policy. I see that since the production and refining of oil have fallen into the hands of one corporation, it bears the appearance of class legislation. I appreciate the inconsistency of permitting the sale of very dangerous gasoline, and prohibiting the less dangerous adulterated kerosene. But on the other hand it must be remembered that kerosene, especially the cheaper grades, is burned chiefly by the ignorant, who cannot protect themselves; that indeed we are all practically without protection except by machinery put in motion by the State; that the use of such oil endangers my neighbor's property equally with my own; and that while it is true that gasoline is more dangerous, so too is powder, but the danger of both is understood and guarded against; and moreover, the gasoline is quite fit for the use to which it is to be

put, while each one should have a right to assume, as all in reality do, that kerosene is fit to store and to burn without unusual precaution.

A word as to what such a statute ought to contain, is in place here. A minimum flash test should be fixed for burning fluids, and regulations formulated looking to the proper storage and consumption of the more volatile oils which are commonly utilized as vapors, and the details referred to this Academy to be settled. A method of inspection and enforcement should be instituted. Finally, the statute should include sufficient appropriations to procure an investigation of the matters connected with the subject which are still obscure, and to carry out its provisions; in short, to make it wisely operative and wisely enforced. Then we may hope to see the last of "Kansas oil." "Why do you call that grade 'Kansas oil?'" I asked the drummer. "Oh, the refiners have to make it or throw the bulk of it into the naphtha, and since they cannot sell it in Missouri, Illinois, Kentucky, Indiana, Ohio, Iowa, or Louisania, they save it for you, and call it Kansas oil."

ON THE TESTING OF BURNING FLUIDS.

BY H. E. SADLER.

The chief danger from a burning fluid arises from the explosion of its vapor. Explosion of a gaseous mixture takes place when the sum of the available heat units given off by the metathesis of the uniting molecules and the cooling of the products is sufficient to raise all the constituents, active and passive, to the flame temperature.

Whether this sum, definite for a definite mixture at a definite temperature, will be realized, depends on: First, the calorific power of the combustible; second, the quantity of this substance present; and third, the availability of the heat given off by the cooling products.

Elaborate experiments and rules for determining the safety of an oil from its specific gravity, index of refraction, vapor tension, rapidity of evaporation, &c., (M. M. Salleron, et Urbain, An. de Genie Civ., V, p. 154, 1866; Hager Wagner's Jahr., XII, p. 674; Pelker Dingler's Journal, vol. 189, p. 61; Byasson Compt. Rend., Sept. 4th, 1871, *et al.*), have been shown to be rough but quite unreliable guides. (Engler und Haas' Zeitschrift für An. Chem., XX, pp. 1 and 362.) They all take loose account of the quantity of combustible only, and neglect its heating power and manner of action. The flash test alone seems to take cognizance of all the conditions. This ought to tell us the lowest temperature at which the oil can be made to give off an amount of vapors each of sufficient heating power, so that with the utmost help from the cooling products the whole mixture may be raised to the flame temperature. It is well known that the various testers give results often 30° F. apart; and no one of them constantly gives flashing points, in a series of tests, agreeing within 5°. We are in position now to understand the philosophy of that fact. In an open tester the amount of vapor in the flash chamber will by diffusion be less than in one partly closed, and still less than in one entirely closed. The quality of that which is present will also differ in diffusion, removing the lightest vapors fastest. The availability of heat from the products will also vary. Even if we confine attention to one form of open tester alone, we see that the quantity of vapor is dependent on the temperature of the room, the drafts, the frequency with which the torch is applied, burning up a portion of the vapors already formed, the surface exposed, *i. e.*, the degree to which the oil runs up the sides, the rapidity of heating, the proximity to the oil, and a hundred other conditions which it is impossible to keep constant. The quality of the vapor, too, will vary with the proximity of the oil and the availability of the heat of the products with the drafts, &c., &c.

In a loosely-closed tester the results will depend in a less degree on some of the same conditions, as drafts and proximity of the oil, but in a greater degree on others—such as the amount of vapor consumed in negative trials. Even here it is quite impossible to secure in successive tests an equal quantity of vapor, *i. e.*, an equal *relative saturation* in the air of the vapor chamber. How can this be obtained? At the boiling point of a liquid there is no limit to the amount of its vapor which the air can hold. At any lower temperature, however, the oil will still evaporate, but only to a definite extent; and when this is completed the air is said to be saturated. Now we cannot manage practically to stop the evaporation at each trial when the air is just one-fourth or one-half saturated, but if we aim at complete saturation we can easily hit it, for evaporation will stop of itself, and an equal relative saturation be in this way repeatedly obtained. This may be accomplished in the closed testers, and at the same time we may secure an equal constancy in the other factors, the calorific power of the vapor, and the economy of its heat. It requires, however, care that the oil and air be sufficiently mixed, that the resulting spray be equally well removed, and such other careful manipulation that the results are in general nearly as divergent as in the loosely-closed testers.

The saturation of the air has also been undertaken in the open apparatus of Lieberman (Zeitschrift für An. Ch., XXI, 1), and of Stoddard (Am. Ch. Jour., IV, 4), and their labors have so simplified the manipulation that the shadow of an available oil test has appeared—for here the conditions for saturation depend rather on the apparatus itself than on the handling. The bubbles must be sufficiently minute to effect proximity of every air particle to the oil, sufficiently rapid to secure proper agitation, sufficiently deep to give ample time for vaporization. The outlet of the vapor chamber must be so large that the velocity of the issuing air shall be less than the velocity of flame propagation. The current must be uniform, that uniform benefit may accrue from the products of combustion. With a vessel of given and proper size and shape, with a given and proper guage for the inlet of the air, which shall be forced in under a given and proper pressure, the conditions of the experiment will be virtually constant.

It remains only to determine the relative saturation of air with oil vapor which may occur in our lamps, and to fix our flash test correspondingly below the maximum lamp temperature, to afford the long desideratum—a rapid, reliable, accurate, and easily manipulated oil test. I hope to be able to determine the proper dimensions for such an apparatus.

I have endeavored to explain *a priori* the principle which must underlie a good oil tester, and to explain by it the conspicuous variations in those in use. So also we may account for other phenomena which have been a source of constant inaccuracy in testing oil. Place a flame in a gaseous mixture in which the proportion of the combustible is rapidly increasing, a slight envelope becomes preceptible and gradually enlarges. What are the sources of the heat units, which at the borders of the envelope have raised the gases to the flame temperature while they fail to beyond? Evidently the combustion there going on and the heat radiated from the central flame. As the amount of combustible increases, a less number of heat units are required from the flame, and the envelope extends to a distance where that smaller amount is received. Finally, it reaches the virtual limit of the flame's influence, when the heat units produced by the combustible are alone sufficient, and the flash or explosion immediately follows. Experiment verifies this statement accurately. For an account of the history and methods of oil testing, consult Dr. C. F. Chandler, in Johnson's Cyclopædia, article, Petroleum; Mr. A. H. Elliott's synoptical bibliography in his report to the New York State Board of Health, Second Annual Report, 1882, reprinted as circular No. 45; and a review in Am. Ch. Journal for October, 1882, IV, pp. 280–8 and 293–4, with the papers in each place cited.

SOME LIGHTNING FREAKS IN 1883.

BY J. SAVAGE.

For thirty years my quarter-section has been exempt from lightning strokes, with the exception of two bolts which came down during a shower on the night of July 10th, 1883.

The electrical display on this occasion was of unusual intensity; the bolts were very frequent and brilliant, and seemed more like huge balls of red-hot iron than the usual electrical currents. The display was preceded by the usual stillness of the elements, only this was intensified, seemingly, many fold.

One of the electrical streams before referred to struck an Osage orange tree, and injured it so that its leaves withered and died.

The other instance was more noticeable and worthy of note. The electrical stream entered the top of a Lombardy poplar tree, following down the body and peeling it to within three or four feet of the ground, where it left the tree and entered a couple of half-round iron rods about the size of a man's finger. On these rods the current distributed itself and entered the ground by way of three cedar posts, to which the rods were attached. The gate pulleys, which rested upon the iron rods, also shared in a smaller degree the passage of the subtle fluid. The poplar tree was peeled by the stroke only to a point on a level with the iron rod, below which it was left whole and unharmed, showing that the whole current entered the rods.

The following is a still more graphic account of "lightning's freaks" during the same shower, written at my request by my neighbor Mr. P. P. Phillips, who resides about four miles from my place. This story goes to disprove the old saying that "lightning never strikes twice in the same place:"

The night of July 10th, 1883, is one that will be remembered by us while life and reason last. Commencing at dark, there was one continual grand display of electrical phenomena such as is seldom seen. At about midnight a violent storm of wind and rain struck us from the northwest, and with almost incessant peals of thunder.

We had been up and fastened blinds and made preparations for the storm, and had again retired. Half musing, half asleep, we were suddenly aroused by a terrible shock. Springing to our feet, we found that lightning had struck one of the chimneys, which it had torn almost completely out. The house was also filled with smoke and sulphurous vapors, so that the doors and windows on the leeward side of the house had to be opened to escape suffocation.

Finding that the family had all escaped injury except being somewhat stunned, we now proceeded to examine as to the possibilities of fire. Entering another room in the chamber, and while near another chimney, we suddenly found ourselves sitting on the floor. Gathering up in an instant, we found *this* was now struck, brick and mortar flying in all directions, and *another* charge of the sulphurous vapor,

Now fully convinced that lightning might strike in very nearly the same place, and that too within the space of five minutes, we at the instant made no further investigations with regard to the flues and the upper part of the house. This was about one o'clock, and after another hour the storm had passed.

In the morning the night's work was examined carefully. The first chimney struck was on the east of the house. This was torn out half-way to the floor. The stoppers to the stovepipe holes, both in the chamber and in the dining-room below, had been driven in an exactly horizontal position across the rooms, fourteen feet, and breaking through the glass in the windows, were lodged in the blinds and just reversed in position.

A neighbor a short distance away, who was witnessing the storm and saw this chim-

ney demolished, states that the lightning came down like a huge ball of fire. The second chimney was about in the predicament of the first. The lightning had descended to the kitchen stovepipe, then followed it across the room sixteen feet, and tearing it apart, jumped two feet into the brick lining of the house, thence into the guttering on the side of the house, melting it in three or four places, thence down the pipe, tearing off the corner-boards of the house, and made its exit in a barrel of water.

The family were troubled with a sort of lassitude for two or three days, and with myself were affected with a severe nausea for about a week.

This wonderful, invisible, subtle element which is so terribly sudden and potent in its operations, we now look upon with more mystery than ever.

NOTES ON TEA ANALYSIS.

BY H. R. BULL.

The following notes on tea analysis were made while pursuing an inquiry concerning the adulterations found in our ordinary articles of food.

I had collected from our city grocers a variety of samples for analysis, ranging from the highest-priced to the cheapest teas in the market. The general methods used were those given in Wauklyn's work on tea, coffee and cocoa analysis, following the scheme proposed by him in the determination of ash and extracts.

Wauklyn's method of ash-determination was to incinerate a weighed quantity of the tea in a platinum crucible. I found, after a rather costly experience, that it would not do to use platinum crucibles. We had in the laboratory two new crucibles, which I used. I noticed, after the first incineration, that the bottom of the crucible was affected, and after the second it was cracked and eaten so badly that it was unfit for further use. Supposing it was due to poor platinum, I tried the other new crucible, and it was likewise ruined. An old crucible, that had been long in service, and was known to be of good material, was next tried; after two or three incinerations it also was spoiled. A little study on this convinced me that the bad effects on platinum were due to the presence of phosphoric acid, which is decomposed by heat. The platinum unites readily with phosphorus, forming the brittle silver-white, easily fusible phosphide of platinum, which spoiled the crucibles. Upon a subsequent quantitative determination, I found tea ash to contain 21.24 per cent. of $P_2 O_5$.

Porcelain crucibles were afterwards used, with quite satisfactory results. The percentages of ash in seven different teas were as follows:

Best Japan, price unknown,	5.158
Black Oolong, price unknown,	5.957
Japan, @ 70c.,	6.056
Japan, @ 50c.,	6.421
Japan, @ 50c.,	6.085
Young Hyson, @ 25c	6.953
Japan siftings, @ 25c.,	12.849

By adding water to the ash in a beaker, grains of sand could be seen in every case. Probably some sand is necessarily accumulated in gathering and in transportation, but if the ash much exceeds 6 per cent. it is questionable whether it is not partly intentional. It may be noticed in the results given, that the ash increases much as the price diminishes.

Zöller has found that the ash of tea leaves from which all sand had been carefully removed contained 4.35 per cent. of silica. In the specimens under consideration I find the total amount of silica as follows, the figures being percentages of the ash:

Best Japan, price unknown,	7.734
Black Oolong, price unknown,	9.367
Japan, @ 70c.,	11.100
Japan, @ 50c.,	10.059
Young Hyson, @ 25c.	18.538
Japan siftings, @ 25c.	54.075

In these determinations the tea was taken as it is in commerce, without any attempt to remove impurities. Calculating then from Zöller's result for silica, the amount of sanding would be represented in my silica determinations by the excess of 4.35 per cent. In the Japan siftings the sand as an adulteration amounts to 6.89 per cent. of the weight of the tea.

The amount of extract, more than any other test, gives an insight to the real value of the tea as regards strength, as this term is popularly used.

Percentages of extract were:

Japan, best,	37.766
Oolong, black,	33.266
Japan, @ 70c.,	37.692
Japan, @ 50c.,	37.116
Young Hyson @ 25c.,	29.933
Japan siftings, @ 25c.,	27.450

The small percentage of extract in some cases, indicates that the tea leaves were partly spent, probably on account of being exposed to dampness in transportation; also, the extract would be governed somewhat by the amount of sand present.

It is very generally supposed that the cheaper teas contain mineral impurities, due to the method of curing. I tested in two of the cheaper teas for Pb. and Cu., the supposed impurities, but did not find either.

In general it may be said, that though teas are often adulterated, the adulterations are of a harmless nature, and generally governed in amount by the price.

METEOROLOGICAL SUMMARY FOR THE YEAR 1883.

PREPARED BY PROF. F. H. SNOW, OF THE UNIVERSITY OF KANSAS, FROM OBSERVATIONS TAKEN AT LAWRENCE.

The chief characteristics of the weather of 1883 were the low mean temperature of all its months except April, November and December; the unusually long period of immunity from severe frost; the large and well-distributed rainfall; the slight preponderance of northerly over southerly winds; the high average wind velocity; the very high mean barometer, surpassing that of any previous year of our sixteen years' record; and the remarkably brilliant and long-continued orange and crimson sunrise and sunset glow of the last five weeks of the year.

TEMPERATURE.

Mean temperature of the year, 51.66°, which is 1.87° below the mean of the fifteen preceding years. The highest temperature was 96.5°, on July 23d; the lowest was 14° below zero, on the 22d of January, giving a range for the year of 110.5°. Mean at 7 A. M., 45.76°; at 2 P. M., 60.42°; at 9 P. M., 51.66°.

Mean temperature of the winter months, 27.10°, which is 3.12° below the average winter temperature; of the spring, 53.38°, which is .61° below the average; of the summer, 73.20°, which is 3.17° below the average; of the autumn, 52.99°, which is .24° above the average.

The coldest month of the year was January, with mean temperature 19.65°; the coldest week was January 17th to 23d, mean temperature 4.66°; the coldest day was

January 20th, mean temperature 7.3° below zero. The mercury fell below zero eight times, of which five were in January and three in February.

The warmest month was July, with mean temperature 76.18°; the warmest week was June 30th to July 6th, mean 81.30°; the warmest day was July 20th, mean 83°. The mercury reached or exceeded 90° on 26 days (16 below the average number), viz.: one in May, six in June, seventeen in July, one in August, and one in September.

The last hoar frost of spring was on May 22d; the first hoar frost of autumn was on October 14th, giving an interval of 135 days, or nearly five months, entirely without frost. The average interval is 155 days.

The last severe frost of spring was on March 29th; the first severe frost of autumn was on the 1st of November; giving an interval of 217 days, or nearly eight months, without severe frost. The average interval is 199 days. No frost during the year caused damage to crops of grain and fruit. The low temperatures of January and February were generally destructive to peach buds.

RAIN.

The entire rainfall, including melted snow, was 40.65 inches, which has been but twice exceeded on our sixteen years' record (in 1876 and 1877), and is 6.40 inches above the annual average. Either rain or snow, or both, fell on 106 days—three more than the average. On two of these days the quantity was too small for measurement.

There was no approach to a drouth during the year, the longest interval without rain in the growing season being eighteen days, from August 25th to September 7th.

The number of thunder showers was 32. Hail fell on two days, February 3d and May 13th.

SNOW.

The entire depth of snow was 12.50 inches, which is 8.57 inches below the average. Of this amount, five and a half inches fell in January, four inches in February, one inch in October, and two inches in December. Snow fell on 21 days. The last snow of spring was on March 24th; the first snow of autumn was on October 24th.

FACE OF THE SKY.

The average cloudiness of the year was 45.24 per cent., which is .84 per cent. above the average. The number of clear days (less than one-third cloudy) was 169; half-clear (from one to two-thirds cloudy), 98; cloudy (more than two-thirds), 98. There were 71 days on which the cloudiness reached or exceeded 80 per cent. There were 55 entirely clear and 50 entirely cloudy days. The clearest month was November, with a mean of 58.22 per cent.; the cloudiest month was October, mean 58.27 per cent. The percentage of cloudiness at 7 A. M. was 49.47; at 2 P. M., 48.66; at 9 P. M., 37.59.

DIRECTION OF THE WIND.

During the year, three observations daily, the wind was from the S. W. 291 times, N. W. 250 times, N. E. 219 times, S. E. 166 times, S. 58 times, N. 47 times, E. 35 times, W. 20 times. The north winds (including northwest, north and northeast) outnumbered the south (including southwest, south and southeast) in the ratio of 516 to 515.

VELOCITY OF THE WIND.

The number of miles traveled by the wind during the year was 141,164, which is 2,787 miles above the annual average for the ten preceding years. This gives a mean daily velocity of 386.75 miles, and a mean hourly velocity of 16.12 miles. The highest hourly velocity was 60 miles, on May 13th; the highest daily velocity was 1,010 miles, on January 10th; the highest monthly velocity was 15,661 miles, in May. The three windiest months were April, May, and December; the three calmest months were June, August, and September. The average velocity at 7 A. M. was 15.19 miles; at 2 P. M., 17.96 miles; at 9 P. M., 15.58 miles.

BAROMETER.

Mean height of barometer column, 29.135 inches, which is the highest annual mean on our record. Mean at 7 A. M., 29.154 inches; at 2 P. M., 29.114 inches; at 9 P. M., 29.137 inches; maximum, 29.869 inches, on February 17th; minimum, 28.289 inches, on April 22d; yearly range, 1.580 inches. The highest monthly mean was 29.340 inches, in February; the lowest was 28.957 inches, in April. The barometer observations are corrected for temperature and instrumental error only.

RELATIVE HUMIDITY.

The average atmospheric humidity for the year was 69.7; at 7 A. M., 79.85; at 2 P. M., 53.36; at 9 P. M., 76.01. The dampest month was January, with mean humidity, 79.1; the driest month was April, mean humidity, 53.3. There were eighteen fogs during the year. The lowest humidity for any single observation was 10.5 per cent., on April 17th and 24th.

THE SEVENTEENTH ANNUAL MEETING.

TRANSACTIONS.

In response to the generally expressed wish of the members of the Academy, the Executive Committee called the seventeenth annual meeting at Lawrence, on November 24th, 25th, and 26th, 1884, the sessions being held at the University. The following abstract of the proceedings includes the business transactions of general interest, and the papers read at the sessions, so far as furnished for publication by their authors and accepted by the Committee on Publication.

The proceedings of the afternoon of the 24th were of a general business nature, including the annual reports of the officers of the Academy and the appointment of temporary committees.

At the evening session the annual address of the President was delivered by Dr. Brown, as follows:

IS A GEOLOGICAL SURVEY OF THE STATE A NECESSITY?

In accordance with the custom and rule of this Academy, the President is required to deliver an address at each annual meeting, on some subject pertaining to the work of the past year, or on the advancement and progress of science in our midst. In response to this, the work and labor of the members of the Academy will be presented to you during the meeting, as they have come fully prepared with papers of great value and interest, covering all branches of science, with new discoveries and new developments in every department. Time, labor and money have been expended by them to bring together so much original investigation and research, that will be appreciated by scientists everywhere, and by the people of our State.

We will devote the remainder of the evening to something we deem of vital importance to our State. That is, the question of a geological survey of Kansas. If we can convince you, and through you the great mass of our citizens, that there is a necessity that such a work should be made, and that the benefits derived from it will be one hundred fold of the cost attending the same, our labor in bringing this subject before you will not be without some good results.

This Academy was organized for the advancement and promotion of scientific knowledge. In pursuit of it, many facts in regard to the resources of the State have been made public, which have proved of value to the people of this commonwealth. Take, for instance, the weather reports of Profs. Snow and Lovewell, which have been furnished to the public; the botany of the State, by Prof. Carruth; the geological formations, by the late Prof. Mudge; besides mineral deposits, insect life, etc., by the members of the Academy.

We know very little in regard to our mineral wealth. The digging of a well has developed coal, opened up lead mines, brought forth mineral waters, and unearthed hidden treasures. If the State should take hold of a geological survey and prosecute it faithfully, the public would find that Kansas possesses within her limits, valuable resources which now lie idle and unknown. What is there in a geological survey that the farmer, merchant and mechanic should lend his aid and influence in securing an appro-

priation for this purpose? He might say, if coal was found in his vicinity in great abundance, it would reduce the price. If the rainfall could be regulated, so they could get it when needed; if frost would only come in winter; if grasshoppers could be kept away; if all the various insects that prove so destructive to fruit and grain could be rendered harmless, a geological survey would be a good thing. We all agree to this, and believe a great deal may be accomplished in benefiting the public that they do not know of now, and much more to the development of the State.

A bill was introduced during the last meeting of the Legislature, asking for a small appropriation for a geological survey. A large number of the members thought it a good thing, but the railroad bill should pass first. Others said it cost too much — can't afford it. Others asked, What is the use of a geological survey? Another answered the question by saying, A geological survey is to pay expenses of someone for collecting old bones and minerals that are found scattered over the prairies. These are some of the objections to a geological survey, showing that the purpose and object is not generally known. Some think it is merely a topographical survey, that refers to the surface entirely and has little or nothing to do with anything that is found below the surface. From the various opinions that people have in regard to it, we believe that a great many do not understand what a geological survey is, or the benefits derived from it. If properly understood, we believe there would be no difficulty in securing an appropriation for the work.

We shall endeavor briefly to state what a geological survey is, and some of the advantages of it. It comprises the study of everything below the surface, where the most valuable part of the earth may be found — boring and digging into the crust of the earth to any depth that may be necessary to develop everything that may be of value. Should coal be found, all information in regard to the area, depth, thickness of vein, character and value for heating purposes, and probable cost of mining the same, would be fully noted. Location of lead and other minerals, the districts in which they may be found, their depth, and all other information that may prove of value. Clays of various kinds for the manufacturing of pottery, tiling, brick, etc. Chalk, limestone, sandstone, gypsum and other materials used for building purposes. Zinc, bismuth, arsenic, strontia and other materials used in the arts; the cost of mining the same, and their commercial value. Also, the botany of the State, showing the distribution of the timber and vegetable growth indigenous to the State. Water power on all the rivers and streams, and the fall from various points, with such information as will enable every one to understand their availability as water power for manufacturing purposes. An analysis of all the mineral waters, gas wells, their extent and value, the practicability of using the gas for fuel and lighting purposes. An examination of the character of the soil from all the counties in the State, with an analysis of the same, indicating the soil suitable for the growth of various agricultural productions, in such a way as to be of practical benefit to the farmer. Rainfall and temperature should be accurately obtained. Considerable attention would be given to the eradication and means of the destruction of insects that are injurious to fruit and fruit trees, and prey on the products of the soil; these and many other things will be developed that will prove a benefit to our people, and of immense value to the State. County maps should be made, giving a full history of the resources of the county, describing accurately the depth, location and character of all coal deposits, clays, building stones, soils, water power, and all information that would be of value to the counties, and cost of utilizing the same. Publishing maps for the counties, supplying the people with the reports of the survey, and disseminating information during the progress of the work. All these come within the range of a geological survey, and properly belong to it.

To do this work, an expenditure of money will be necessary; less than $100,000 dur-

ing the next ten years will be sufficient to cover the expenses of it. In return for this outlay, we cannot estimate in dollars and cents the value to the State. We have the evidence of the most prosperous States where surveys have been made, that it has been of untold value to them. It is a work of great importance, benefiting all the citizens alike, bringing prosperity, building up and developing the State and publishing the advantages that we possess, now hidden from view; saving thousands of dollars to people who without any knowledge of what we have, engage in enterprises that may or may not be a success. The useless waste of money would be prevented. With a geological survey, almost a certainty in regard to success would be secured.

If you want to mine for coal, you will know where the depth and quality can be found; if for lead, zinc and other metals, reference to the geological survey will tell you; questions as to mineral waters, building materials, etc., will be fully answered. At the present time, there is considerable interest manifested in regard to the sinking of artesian wells in the western part of the State, which cannot be done until a geological survey has been made, and to delay now would be hindering the growth and development of our State. We believe it would be for our best interests.

In order to get the experience of other States that have had geological surveys, I mailed to the Secretary of each of the States in the Union a number of questions, as follows:

Has a geological survey of your State been made?

If so, when was first appropriation, and what amount?

Has appropriation been made each year since?

How much have been the total appropriations?

What practical benefit have the people derived from it?

Mention some of the industries that are in operation which have derived their origin and success from the geological survey.

Any other information that you may have that will aid us, please give.

Replies have been received from twenty-nine States. Those not heard from belong to extreme South and new States in the West. We received the following, which I will read to you in regular order:

MAINE.

The State of Maine has had no geological survey since 1861, and then it was but a partial survey, under the direction of the Board of Agriculture. A similar survey, under the same direction, was made in 1839. The reports made at that time have been exhausted.

NEW HAMPSHIRE.

A statement received in reply to inquiry of March 10th, 1884, shows that a geological survey of the State of New Hampshire has been made, and June 24th, 1839, there was an appropriation of $2,000 to carry on the work of surveying; this amount was to be paid annually for three years. The total appropriations have been upwards of $60,000.

A full history of the geological survey of this State can be found by referring to vol. 1, Geology of New Hampshire, by Hitchcock, (Concord, Edward Jenks, State Printer,) 1874, in our State Library.

VERMONT.

Vermont has had a geological survey. The first appropriation was made in or about 1830; they then appropriated $2,500 a year. In answer to the question concerning the benefit this survey has been to the people, the report says: Our marble and granite interests have been promoted extensively. We have now extensive quarries, employing thousands of men, which before were unsuccessful, and much money was lost, as the lay of the limestone had not been determined, and work was a subject of guess.

RHODE ISLAND.

In 1839 and 1840 a geological survey of the State of Rhode Island was made. At the January session of the General Assembly, in 1839, they appropriated $2,000 to the advancement of the survey. There has been no subsequent appropriation: making the total amount of appropriations only $2,000.

The Secretary of State in his report further states, that owing to the lapse of time since the survey was made, he is unable to state what benefit the people have derived from it. He also adds that it was evidently deemed important when the survey was made, as he finds that the Rhode Island Society for the Encouragement of Domestic Industry, at a meeting held December 28th, 1838, voted to appropriate $500 in aid of the survey, provided, however, the State should appropriate the residue. At the January session of 1875 a commission was appointed to prepare a plan for a geological survey of the State. They made a report, but no further action was taken. Five hundred dollars was appropriated for the purpose.

CONNECTICUT.

Communications from Connecticut report that there has never been any geological survey of their State made.

NEW YORK.

Professor John Hall, State Geologist of New York, makes the following statement in reply to our inquiries, referring to the questions in the order of one, two, three, four and five, as marked in the margin:

1. A geological survey of the State has been made.

2. In 1836 an appropriation was made of $104,000, to cover the salaries of a geologist, a botanist, a mineralogist and four geologists, with their assistants, together with the current expenses of the field-work for four years.

3. The appropriations made since that time have been chiefly for the publication of the natural history of the State, including botany, zoölogy, mineralogy, geology, paleontology, and agriculture. These appropriations have not always been made annually, though expenses have been annually incurred. The expenses have been for publication and for the salaries of those engaged in the work. The publications embrace the quarto volumes of natural history, and the reports (octavo) of the State cabinet and State museum.

4. The total of appropriations, including that of 1836, together with the appropriations for the publications of the natural history, the establishment and support of the State museum, and the publication of its reports for thirty-six years; also the publication of the natural history of the State, a highly-illustrated work, which now numbers over twenty bound volumes of 3,000 copies each, making in all 75,000 quarto volumes, which have been distributed to the people of the State of New York.

5. Among many other things, great practical benefits have arisen from the fact that the limits of the vein-bearing formation in the State have been pointed out in the several geological groups, and their areas delineated upon the maps. This knowledge has encouraged the application of intelligent industry to their development, and their production is an immense source of profit to those engaged in the work.

The limits of the true salt-bearing formations are shown upon the maps, and the original suggestion, that the source of the brine spring was in the solution of rock salt in the undisturbed strata, has been verified. The working of this product has of late become an important industry, which is likely to be extended in the near future.

Formerly, much time and money were wasted in fruitless endeavors of borings for brines in the lower formations which the geological survey has shown to be barren of such mineral products, or to contain small quantities of very impure brine, with no source of considerable supply. The investigation and publications of the survey have

given confidence in this decision, and there is no longer waste of time or capital in such work.

In the same connection, the limits and extent of the water-line groups have been determined, and this has given rise to a very extensive and profitable industry at localities along almost the entire length of the State—from the Hudson to the Niagara river.

The sources of durable building stones have been indicated by the determination of the limits of certain geological formations.

The search for coal in the block states, in the Hudson valley and localities in the interior of the State, formerly a prolific source of expenditure and disappointment, has ceased among all intelligent men since the relations of the true coal formations to the rocks of New York were determined by the geological survey. Much time and money were formerly expended in fruitless undertakings for the mining of coal. Since the settlement of the State it has been estimated that more money has been spent in this than in the entire cost of the geological survey and its publications.

I may perhaps be allowed to conclude this short statement of the benefits of the survey, by quoting some paragraphs from a report made to the Committee on Public Education of the New York Assembly in 1870:

"In the estimates of the products of the geological survey there is one element that cannot be given in figures—this is the knowledge which is the result of the survey, and which, if not everywhere evidenced in positive action, can in some degree be estimated by its negative effects. Intelligent people can no longer be found to form companies and expend thousands of dollars in the Hudson or Mohawk valleys, or in the southern tier of counties, in search for coal in the block states. People no longer bore wells in the Medina sandstone in search of productive brines, nor look in the Catskill mountains for granite.

"The limits of our great iron-bearing formations are well defined and fully understood by all intelligent men, and neither iron ore, lead or silver are sought as formerly in the broad agricultural belts south of the great limestone terrace. There is a general confidence in the result of the survey, coming from the conclusion that science has given fixed views and opinions which no assertion of empiricism can set aside.

"Before the completion of the geological survey of the State of New York, there was not a single text-book upon geology for the use of our schools. The many thousands of copies now in use, all teaching the same facts, attest the value of the geological survey.

"If the treasurer of the State does not show the credit of these text-books, the authors and booksellers have profited, and the students of our educational institutions have from this source become more intelligent citizens of the commonwealth.

"The knowledge resulting from the geological survey of New York, and its language and nomenclature, are everywhere recognized, and have become more intelligently incorporated into the scientific literature of our civilized people."

I might go on almost indefinitely with statements of the advantages which have resulted from the geological survey of the State of New York, but I believe I have said enough to answer the object of the inquiry.

PENNSYLVANIA.

By an act which passed the Legislature of Pennsylvania in 1874, the sum of $35,000 was thereby annually appropriated for three years to conduct a geological survey of that State. In 1876 an additional appropriation of $15,000 was made. For the year 1877 an appropriation of $50,000 was made. Again, the sum of $150,000 was appropriated. Subsequently there was an appropriation of $125,000 for this work, provided, however, that not more than $50,000 should be expended in any one year; and provided further, that the said survey shall be completed, as far as the field-work is concerned, by the end of the calendar year 1883. In June, 1883, $50,000 was again appropriated, for the continuance of the survey of the anthracite coal region of the State. A committee was also appointed to examine into the manner and efficiency of the work of the second geological survey, and report. The report is published in Part 5, Legislative Documents. (See above-named pamphlet laws in State Library; you will there find all information that can be obtained on this subject.) Total appropriations have amounted

to $445,000. The report of the committee, and the amount and continuance of appropriations, justify the opinion that the work has been regarded of practical benefit to the State.

MARYLAND.

In the State of Maryland geological surveys were made about the years 1837, 1838, 1841, and 1842. There was an appropriation of something over $10,000 about 1850 and 1864; not in one year, however, but from two to ten years. No late appropriations have been made.

The report further states that the geological survey of this State has been of great practical benefit to the people. Mines of bituminous coal have been opened and worked; also iron and copper mines, quarries of stone and marble, beds of shell marl and other marl used as fertilizers, and other valuable resources of the State, have been developed by this means.

The Secretary of the State in his remarks further states: "The resources of your State can never be known or fully developed without an extended survey by a competent geologist. Such has been the experience in our State."

VIRGINIA.

The State of Virginia has had only a partial survey. Appropriations have been made as follows: From 1835 to 1842, inclusive, the appropriations amounted to $19,500. No appropriations have been made since.

The work of this survey was undertaken in 1835 by Prof. W. B. Rogers, and prosecuted faithfully until the appropriations were cut off. Scientific men say that this work is of immense value, but the reports have never been published.

SOUTH CAROLINA.

South Carolina, between the years 1840 and 1850, had a partial survey made. No appropriation was then made, and no work since.

GEORGIA.

The geological survey of Georgia was organized in 1874, with an appropriation of $50,000, allowing an annual expenditure of $10,000. No additional appropriations had been made at the expiration of the fifth year, and the work was suspended.

Among the advantages of this survey, we find that attention was called and work commenced in a number of gold, copper, pyrites, mica, asbestos and graphite mines. Iron and coal areas before generally unknown.

Florida, Alabama, Mississippi, Louisiana, Tennessee and Texas have had no survey.

KENTUCKY.

The geological survey of Kentucky is now in progress. In 1837 there was an appropriation made of $10,000. Appropriations have since been made each year. The total appropriations amount to upwards of $154,000.

In mentioning the benefits the State has derived from this survey, the Secretary of State says: "Railways have been built, mines opened, etc. One factory at Frankfort — string hemp yarns for binding grain — was organized by the geological survey, and brings about $400 into the State each day. One company brought to the State through the instrumentality of the survey has already expended $1,000,000, and will expend much more."

OHIO.

A geological survey of the State of Ohio was made, and an appropriation was given in 1836. The appropriations since then have been made from time to time, as required, making the total appropriations amount to about $100,000. It has been quite beneficial to the State, as it has resulted in attracting to and developing the mineral resources of the State, and thus extending the coal and iron industries.

INDIANA.

There have been five different surveys of the State of Indiana, beginning about 1837, when $1,000 was appropriated. Appropriations have been made each year subsequent to 1860; total appropriations amounting to not less than $100,000; usual appropriations amounting to $5,000 or $8,000. It has been of great practical benefit to the people, as it has enhanced the taxable value of the State several millions; induced the building of one hundred miles of railway; suggested and created the erection and maintenance of blast-furnaces, rolling mills, nail mills, glass works, potteries, tile works, terra cotta works, and opened an annual export of crude materials to the amount of from $800,000 to $1,200,000 annually. It has especially created a market for our superior block coal, and gives direction to sale of such materials as stone and clay in new markets, to the amount of $100,000 to $200,000 annually. It has, by discovering road materials, increased gravel roads all over the State.

As important, or even more so, the State Geologist authoritatively, in open office, gives information to citizens or foreigners as to the minerals, soils, stone, lime, gravel, and other products of the State; its soils, forests, water, etc., being a constant advertising agent for daily exhibiting its interests.

ILLINOIS.

In 1851 there was an appropriation of $3,000 per annum for the purpose of carrying on a geological survey of the State of Illinois. After a term of two years this appropriation was increased to $5,000. The appropriations continued until 1873; the total amount of appropriations have been $110,000. The people have been greatly benefited by this survey; coal mining has been extended over nearly two-thirds of the State with profit, and manufacturing industries of various kinds have sprung up in consequence of an abundant supply of cheap fuel, bringing hither the raw materials of other States and enabling our people to successfully compete with Eastern manufacturers, in nearly every department of manufacturing. The zinc and iron ores of Wisconsin and Missouri are brought here in large quantities for smelting, and valuable deposits of fire clay, potters' clay, and mineral paints, together with building stone and marbles in extensive deposits, have been made known through the reports of the geological survey.

MICHIGAN.

In 1869 an annual appropriation of $8,000 was made for the purpose of a geological survey of the State of Michigan, to continue for so long a time as was necessary to complete the survey. The mining industries of this State, producing iron, copper and salt in immensely large quantities, do not seem to have originated as the result of previous geological investigation, but its progress was decidedly benefited by a close scientific investigation of the structure of the earth's crust covering our State, and mining operations became more systematic and less hazardous. Also, the knowledge of the general soil of the country in which we live, the building materials, etc., is of great importance to every inhabitant cultivating the soil or following any other vocation.

WISCONSIN.

A geological survey of the State of Wisconsin was made about the year 1853. In that year the first appropriation was made, of $1,375. Appropriations have been made each year since, amounting to $107,206. For references, see Prof. T. C. Chamberlain, State Geologist, Beloit, Wisconsin.

MISSOURI.

Missouri has had a partial geological survey, but it was discontinued in 1874. Reports show that it defined the boundaries of the coal fields, iron, lead, and zinc districts.

ARKANSAS.

A geological survey of Arkansas was made some twenty-five years ago.

Appropriations were made during the years of 1856 and 1857, amounting to about $4,800 per annum. Subsequently, appropriations were made in 1858 and 1859. The total amount of appropriations, as near as can be ascertained, are $10,800.

Although the survey was discontinued before it was completed, yet it has been the means of great benefit to the people.

This testimony is of great value to us, and enables us to arrive at a certainty in regard to the benefits derived from a geological survey. The most prosperous States in the Union to-day, are those where a thorough and systematic survey has been made, and this I believe to be without exception. Their growth and prosperity date from the time they commenced the work; every State has been amply remunerated for the outlay. It is of great importance to do it at once; the western part of our State is interested in the sinking of artesian wells, and its prosperity depends largely on the State taking hold of it and determining the result successfully. These wells cannot be sunk without a knowledge of the geological formations, and that part of the State cannot prosper without this is done. We believe everyone is in favor of the advancement and development of the State. If the Legislature wishes to advance its interests, nothing better could be done. A failure to take favorable action is simply hindering the progress of the State, and its development. Ohio, Indiana, Pennsylvania, Illinois, Kentucky, and others, report to us that a geological survey has done more for their States than anything else, and has resulted in finding coal, stone, minerals, &c., previously unknown, which has brought wealth and prosperity to their people.

Why anyone should oppose this, or be indifferent to a measure productive of so much good, is a mystery. We trust the people of Kansas will be alive to their interests and urge the Legislature to make the necessary appropriation.

PROCEEDINGS OF THE SECOND DAY.

TUESDAY, NOVEMBER 25, 1884.

The President, Dr. Brown, in the chair. Upon the recommendation of the Committee on Nominations, the following persons were elected to the offices named, for the term of one year:

President—R. J. Brown, of Leavenworth.

Vice Presidents—E. L. Nichols, of Lawrence, and G. H. Failyer, of Manhattan.

Treasurer—A. H. Thompson, of Topeka.

Secretary—E. A. Popenoe, of Manhattan.

Curators—O. H. St. John, of Topeka; J. H. Carruth, of Lawrence; J. T. Lovewell, Geo. S. Chase, and F. W. Cragin, of Topeka.

Librarian—F. W. Cragin.

The following papers were read:

ADDITIONS TO THE CATALOGUE OF KANSAS COLEOPTERA FOR 1883 AND 1884.

BY WARREN KNAUS, SALINA, KANSAS.

The following one hundred and sixty species of Coleoptera were mostly taken in Saline and Wilson counties. Fifteen species were added by Professor F. H. Snow, from the vicinity of Lawrence; five were added by Mr. A. W. Jones, of Salina, and numbers 25*b* 51*a*, Ataenius, sp. 6779, 6807 and 6808, were taken in Wallace and Gove counties in 1878 by Professor Snow, and published in the Transactions of the Academy for that year, but have never been transferred to the general list. The species from Saline county were taken near Salina and Brookville, and those from Wilson county, near Buffalo. In the list the locality of each species is given, with occasional notes as to habits, some of which I trust may be of assistance to collectors.

These additions bring the Kansas list of Coleoptera up to about 2,059 species and varieties, and still keep it at the head of State lists in the number and variety of Coleopterous forms.

For the determination of most of the species here given, I am indebted to the kindness of Mr. Henry Ulke, of Washington, D. C., to whom many thanks are due.

The numbers prefixed are those of Crotch's Check List, with Austin's supplement:

25*b*. *Cicindela* venusta Lec. Snow. 1878. Wallace county.

51*a*. *Cicindela* micans Fabr. Snow. 1878.

103. *Notiophilus* semistriatus Say. Snow. Lawrence and Manhattan.

241. *Dyschirius* pilosus Lec. Salina. Two specimens from margin of Smoky Hill river.

248. *Aspidoglossa* subangulata Chd. Salina and Buffalo. Not common.

256. *Clivina* rubicunda Lec. Buffalo. Rare.

258. *Clivina* rufa Lec. Buffalo. Rare in mud on margin of stream.

277. *Schizogenius* ferrugineus Putz. Buffalo. Rare. Same locality as 258.

301. *Brachynus* kansanus Lec. Salina. One specimen.
357. *Lebia* fuscata Dej. Snow. Lawrence.
404. *Cymindis* pilosa Say. Jones. Salina. One specimen.
539. *Loxandrus* tæniatus Lec. Buffalo. Rare.
7544. *Amara* texana Putz. Salina. Rare.
7548. *Brachylobus* lithophilus Say. Brookville. Rare.
7551. *Chlœnius* platyderus Chd. Manhattan. Not common.
944. *Harpalus* nitidulus Chd. Brookville. Not common.
1025. *Bembidium* paludosum Sturm. Buffalo. On margin of stream.
1062. *Bembidium* lugubre Lec. Chapman Creek. Dickinson county. Rare.
1120. *Bembidium* pedicellatum Lec. Salina. One specimen.
1132. *Tachys* pumilus Dej. Buffalo. Three specimens.
1139. *Tachys* lævis Say. Buffalo. Rare.
1173. *Haliplus* fasciatus Aube. Buffalo. Two specimens.
1212. *Hydroporus* mellitus Lec. Buffalo. Common in Elder Branch creek.
1239. *Hydroporus* semirufus Lec. Buffalo. Common in Elder Branch creek.
1339. *Coptotomus* longulus Lec. Salina. One specimen.
——. *Hydræna* Sp. Buffalo. In Elder Branch creek.
1431. *Helophorus* linearis Lec. Buffalo. One specimen from Elder Branch creek.
1513. *Hydrobius* rufiventris Horn. Brookville. In mud in pools.
1533. *Cercyon* centromaculatum St. Salina. Common in places.
1539. *Cercyon* anale Er. Buffalo and Salina. Rare.
1668. *Oxypoda* sagulata Er. Salina.
1791. *Staphylinus* violaceus Gray. Jones. Salina. One specimen.
——. *Philonthus* varians Payk. Salina. Common.
——. *Philonthus* jocosus Horn. Buffalo. Common in mud on margins of drying pools in Elder Branch.
1852. *Xantholinus* hamatus Say. Salina.
1883. *Crytobium* pimerianum Lec. Buffalo and Salina.
——. *Echiaster* sallei Fauv. Salina. Rare.
1988. *Platystethus* americanus Er. Salina. Common.
——. *Oxytelus* near placusinus Lec. Salina. Not common.
7818. *Oxytelus* placusinus Lec. Buffalo. Not common.
2002. *Trogophlœus* 4-punctatus Say. Buffalo. In mud on margins of drying pools.
2159. *Trimium* parvulum Lec. Buffalo. Taken in sifting leaves and decaying wood.
7927. *Choleva* clavicornis Lec. Salina. Taken on a rabbit-foot bait.
——. *Scydmænus* sp. Salina.
2310. *Corylophus* marginicollis Lec. Salina. Not common.
2313. *Sericoderus* obscurus Lec. Salina. Rare.
2323. *Sacium* scitulum Lec. Salina. Common.
2374. *Corticaria* americanus Mannh. Salina. Common.
2382. *Corticaria* cavicollis Lec. Salina. Not common.
2387. *Corticaria* pumilus Mels. Salina. Common.
2455. *Rhymbus* ulkei Cr. Manhattan. Rare.
2467. *Litargus* tetraspilotus Lec. Salina. Not common.
2476. *Sphindus* americanus Lec. Salina. Rare.
2554. *Cryptophagus* crinitus Zimm. Buffalo. One specimen.
2572. *Atomaria* ochracea Zimm. Salina. Common.
2675. *Monotoma* americana Aube. Salina. Rare.

2681. *Nemosoma* cylindricum Lec. Salina. One specimen.
8043. *Epurœa* ovata Horn. Salina. Rare.
2898. *Hyperaspidius* militaris Lec. Snow. Lawrence.
2905. *Scymnus* bioculatus Muls. Salina. Rare.
2919. *Scymnus* collaris Mels. Salina. Common.
2978. *Helichus* æqualis Lec. Ottawa and Dickinson counties, under stones and sticks in running streams.
2981. *Elmis* 4-notatus Lec. Buffalo. In moss and mud in pools.
8104. *Heterocerus* undatus Mels. Buffalo. Common. Salina. Rare.
3246. *Onthophagus* canadensis Fabr. Brookville. One specimen.
3263. *Aphodius* ruricola Mels. Salina and Buffalo. Common.
3272. *Aphodius* lividus Oliv. Buffalo. Common.
——. *Atœnius* sp. Snow. Gove county. 1878.
3447. *Macrodactylus* angustatus Beauv. Salina. Not common.
3470. *Diplotaxis* dubia Lec.
3499. *Lachnosterna* burmeisteri Lec. Buffalo. Common.
3548. *Lachnosterna* crinita Burm. Brookville. Rare.
3733. *Melanophila* atropurpurea Say. West Kansas.
3743. *Anthaxia* flavimana Gory. Buffalo. One specimen.
3809*a*. *Agrilus* pusillus Say. Salina. Common.
3813. *Agrilus* 4-guttatus Gory. Manhattan. Rare.
——. *Agrilus* sp. Jones. Salina.
3828*b*. *Agrilus* puncticeps Lec. Salina. Not common.
3864. *Tharops* ruficornis Say. Buffalo. Rare.
4037. *Elater* miniipennis Lec. Buffalo. Rare.
4043. *Elater* obliquus Say. Salina and Brookville. Not common.
4045*a*. *Elater* areolatus Say. Salina and Brookville. Not common.
4162. *Melanotus* tenax Say. Salina. One specimen.
4231. *Athous* equestris Lec. Salina. One specimen.
4500. *Podabrus* poricollis Lec. Snow. Lawrence.
4520. *Telephorus* carolinus Fabr., var. jactatus Say. Buffalo and Salina.
4615. *Pseudebœus* apicalis Lec. Buffalo. Rare.
4625. *Attalus* terminalis Er. Jones. Salina.
——. *Attalus* near nigripes Horn. Buffalo. Rare.
4704. *Cymatodera* bicolor Say. Snow. Lawrence.
4763. *Hydnocera* verticalis Say. Salina. One specimen.
4805. *Ptinus* brunneus Duft. Jones. Salina. Not common.
4852. *Hemiptychus* punctatus Lec. Salina. One specimen.
4927. *Asemum* moestum Hald. Buffalo. Rare.
5018. *Elaphidion* moestum Lec. Buffalo. Rare.
5191. *Acmœops* trivittata Hald.
5371. *Hyperplatys* maculatus Hald. Snow. Lawrence.
5452. *Tetraopes* annulatus Lec. West Kansas.
5503. *Bruchus* musculus Say. Snow. Lawrence.
5505. *Bruchus* exiguus Horn. Salina.
5538. *Zeugophora* abnormis Lec. Snow. Lawrence.
5570. *Coscinoptera* mucorea Cr. Salina. Not common.
8446. *Lema* circumvittata Clark. Salina. Rare.
8459. *Diachus?* chlorizans Suffr. Salina. Rare.
5579*a*. *Monachus* ater Hald. Salina. Rare.
8489. *Cryptocephalus* carinatus Lec. Salina. Rare.

8499. *Cryptocephalus* fulguratus Lec. Salina. Not common.
5643. *Pachybrachys* femoratus Oliv. Salina and Osage county.
5651. *Pachybrachys* cælatus Lec. Salina. Rare.
8511. *Pachybrachys* virgatus Lec. Salina. Rare.
5670. *Xanthonia* Stevensii Baly. Buffalo. Rare.
5695*a*. *Paria* opacicollis Lec. Salina. Common.
5703. *Metachroma* dubiosa Say. West Kansas.
5722*a*. *Chrysomela* Rogersii Lec. Manhattan. One specimen.
5740. *Chrysomela* philadelphica Linn var. Manhattan. Rare.
5781*a*. *Phyllocthrus* nigripennis Lec. Salina and Brookville. Common.
5862*b*. *Œdionychis* limbalis Mels. Salina and Brookville. Not common.
5874*b*. *Disonycha* cervicalis Lec. Salina. Common.
——. *Graptodera* near exapta Say. Buffalo.
5903. *Orchestris* Zimmermanni Cr. Salina. Common on cruciferæ.
5907. *Orchestris* albionica Lec. Salina. Same as above.
5909. *Orchestris* æneicollis Cr. Snow. Lawrence.
5920. *Systena* marginalis Ill. Buffalo. Three specimens.
——. *Crepidodera* n. sp. Osage county. Common.
5937. *Epitrix* hirtipennis Mels. Salina. Not common.
5951. *Psylliodes* punctulata Mels. Snow. Lawrence. Also Salina.
5955. *Stenispa* collaris Baly. Snow.
5962*a*. *Odontata* inæqualis Web. Salina and Buffalo. Not common.
6422. *Dendroides* canadensis Latr. Snow. Lawrence.
6440. *Corphyra* labiata Say. Brookville. Two specimens.
6490. *Anthicus* ephippium Laf. Salina. Rare.
6575. *Pentaria* trifasciata Mels. var. immaculata. Salina. Common.
6625. *Mordellistena* cervicalis Lec. Buffalo, on solidago. Rare.
6642. *Mordellistena* pustulata Mels. Salina. Common.
6757. *Pyrota* discoidea Lec. Buffalo. Rare.
6779. *Cantharis* reticulata Say. Snow. Gove county. 1878.
6807. *Nemognatha* sparsa Lec. Snow. Wallace county. 1878.
6808. *Nemognatha* bicolor Lec. Snow. Wallace county. 1878.
6845. *Xanthochroa* lateralis Mels. Salina. Common.
8779. *Panscopus* erinaceus Say. Snow.
8862. *Sitones* californicus Fahrs. Buffalo. Rare.
8863. *Sitones* sordidus Lec. Snow.
8892. *Lepyrus* geminatus Say. Salina. Rare.
8917. *Macrops* sparsus Say. Salina. Not common.
8991. *Dorytomus* laticollis Lec. Salina. Rare.
9006. *Smicronyx* ovipennis Lec. Salina. Rare.
9007. *Smicronyx* griseus Lec. Salina. Not common.
9015. *Smicronyx* sordidus Lec. Buffalo. One specimen.
——. *Smicronyx* n. sp. Snow. Lawrence.
9083. *Coccotorus* scutellaris Lec. Salina. Common.
9144. *Thysanocnemis* helvolus Lec. Salina.
9257. *Copturus* adspersus Lec. Salina. Common.
——. *Ceutorhynchus* erysimi Fabr. Salina. Introduced from Europe.
9403. *Balaninus* quercus Horn. Buffalo. One specimen.
9454. *Calandra* remotepunctata Gyll. Salina. Rare.
9480. *Wollastonia* quercicola Boh. Salina. Common.

9611. *Phlœosinus* dentatus Say. Salina, on *juniperus virginiana* (red cedar). Common.
9670. *Brachytarsus* limbatus Say. Salina and Buffalo. Not common.
——. *Apion* ovale Smith. Salina. Common.
——. *Apion* obsoletum Smith. Buffalo. Rare.

PREPARATORY STAGES OF HYPERCHIRIA ZEPHYRIA GROTE.

BY PROF. F. H. SNOW, OF THE UNIVERSITY OF KANSAS.

In July 1882, while our University Scientific Expedition was encamped in the Gallinas Cañon above the Hot Springs near Las Vegas, N. M., my son Willie was so fortunate as to discover the first specimen of this beautiful moth. A few evenings later a second specimen flew into our tent, attracted by the light of the camp fire. This species has the primaries of a dark, ashy brown color, each being crossed by a very narrow oblique white band on its terminal third, while each secondary is of a bright yellow color with ash-brown margin and a conspicuous eye-spot quite similar to that of *Hyperchiria Io*.

In 1883, at the same camping-place, no moths were obtained, but in August half-grown caterpillars were found feeding upon the leaves of the scrubby white oak (*Quercus alba* var. *Gunnisoni* Torr.) From their branching, spiny tubercles, and the stinging sensations produced by them upon the hands of my children, I recognized their generic determination, and surmised that the species would prove to be the *H. zephyria*, captured in the preceding year. A considerable number of the caterpillars were brought with us to Lawrence, Kansas, where they fed readily upon the leaves of the Black Oak (*Quercus tinctoria*), and before the end of September passed safely into the pupa stage within thin and loosely constructed but tough and inelastic cocoons, the latter fastened to leaves and other debris or to the sides and bottoms of the breeding-cages.

It was observed in New Mexico that during the day-time the caterpillars were scattered about over the oak upon which they were feeding, but on approach of night they manifested a tendency to arrange themselves in processionary lines along the branches and trunk of the tree. The stinging sensations produced by their spines upon tender hands were often severe, and were accompanied by white swellings of the irritated skin which in some cases continued for two or three days.

The chrysalids lived through the winter, and early in June, 1884, the moths began to emerge. Several males and females were confined in a breeding-cage with the expectation of securing fertilized eggs and the entire cycle of transformations. But the experiment did not prove to be a success. Perhaps the moths, having emerged at an altitude fully one mile nearer the sea level than their original home, were unfavorably affected by the climatic change, and therefore refused to mate.

The following is a description of the

FULL-GROWN LARVA.

Length $2\frac{1}{2}$ to $2\frac{3}{4}$ inches (64 to 70 mm.). General color of upper surface, bright lemon yellow. The second segment (the head is considered to be the first segment) has a transverse brownish-black band. The remaining segments have each eight narrow black longitudinal lines, extending from a point just behind the center of each segment to a point just in front of the center of the succeeding segment. Two of these black lines along the dorsum constitute a pair and are nearly continuous, but are separated by a narrow white line. Two other black lines upon the sides of each pair of segments are more widely separated and constitute a second and third pair. Between the dorsal pair of lines

and each lateral pair is a single black line on each side of the caterpillar, constituting the seventh and eighth of the eight black lines above mentioned. These eight black lines are somewhat obscure upon the third and anal segments. Along the transverse central portion of each segment not intruded upon by the eight longitudinal black lines, and extending downward to the abdominal surface, are six protuberances, each bearing a many-branched spine. These spines are bright yellow in color, except the tips, which vary from light brown to deep black. Below the upper protuberance on each side of the larva are two narrow oblique black lines which if continued upward would meet at the dorsum. The lower extremities of these oblique lines inclose the base of the median protuberance of each segment.

The lower portion of the sides of the larva, and the abdominal surface except its central portion, are of a jet-black color, with two longitudinal narrow broken lines of pure white extending from the fourth to the penultimate segments. The lower of these two white lines is more indistinct than the upper.

The stigmata are of an orange color, each being encircled by a narrow black ring. The head parts and both true legs and prop-legs, together with the central portion of the abdominal surface and the posterior half of the anal segment, are of a bright reddish-brown color and have a highly polished surface.

THE PUPA.

The pupæ average 24 mm. in length by 10.5 mm. in breadth (.94 by .41 inch). They are of a dark-brown, almost black color, with surface finely shagreened and in most cases thickly sprinkled or shaded with a light brick-red "bloom."

CONTRIBUTIONS TO A KNOWLEDGE OF THE HEMIPTERA-FAUNA OF KANSAS.

BY E. A. POPENOE, OF THE STATE AGRICULTURAL COLLEGE.

The following list comprises chiefly the specimens of Hemiptera taken by the writer in the years 1883 and 1884. Substantial aid in collecting has been rendered by Mr. Warren Knaus, of Salina; and in determination of the species by Professor Philip R. Uhler, of Baltimore.

HEMIPTERA-HETEROPTERA.

Corimelæna nitiduloides, Wolff.
cærulescens, Stal.
pulicaria, Germar.
cærulea, (?).
Homœmus bijugis, Uhler.
Pangæus bilineatus, Say.
Amnestus pusillus, Uhl.
Stiretrus anchorago, Fab.
Perillus claudus, Say.
Podisus spinosus, Dallas.
Brochymena arborea, Say.
annulata, Fab.
Ælia americana, Dallas.
Melanostoma sulcifrons, Stal.
Cosmopepla carnifex, Fab.
Mormidea lugens, Fab.
Œbalus pugnax, Fab.
Euschistus variolarius, P. Beauv.
tristigmus, Say.
Hymenarcys æqualis, Say.
Trichopepla semivittata, Say.
Peribalus limbolarius, Stal.
Raphigaster pensylvanicus, DeG.
Thyanta perditor, Fab. var.
custator, Fab. var.
Murgantia histrionica, Hahn.
Charicsterus antennator, Fab.
Anasa tristis, DeG.
Corynocoris distinctus, Dall.
Euthochtha galeator, Fab.
Metapodius femoratus, Fab.
Leptoglossus phyllopus, L.

Neides spinosus, Say.
Dasycoris humilis, Uhl.
Harmostes reflexulus, Say.
Jalysus impressicollis, Stal.
Corizus lateralis, Say.
Leptocoris trivittatus, Say.
Lygæus turcicus, Fab.
reclivatus, Say.
Erythrischius fasciatus, Dallas.
Melanocoryphus bicrucis, Say.
Nysius angustatus, Uhl.
californicus, Stal.
Ischnodemus falicus, Say.
Blissus leucopterus, Say.
Geocoris bullata, Say.
piceus, Say.
Microtoma carbonaria, Rossi.
Ligyrocoris sylvestus, Linn.
Myodocha serripes, Oliv.
Physatochila sp. indet.
Trapezonotus fallax, Say.
Lygus lineolaris, P. Beauv.
Pœcilocapsus lineatus, Fab.
Calocoris rapidus, Say.
Pœciloscytus pusillus, Reut.
basalis, Reut.
Camptobrochis nebulosus, Uhl.
Agalliastes suavis, Reut.
Eccritotarsus elegans, Uhl.
Piesma pusilla, Uhl.
Corythucha arcuata, Say.
Aradus rectus, Say.
similis, Say.
Mezira lobata, Say.
Acanthia lectularia, Linn.
Nabis ferus, Linn.
Phymata erosa, Linn.
Macrocephalus prehensilis, Fab.
Sinea diadema, Fabr.
Prionotus cristatus, Linn.
Fitchia nigrovittata, Stal.
Milyas cinctus, Fabr.
Apiomerus spissipes, Say.
Melanolestus picipes, H. Schf.
Conorhinus sanguisugus, Lec.
Sericophanes ocellatus, Rent.
Salda signoretii, Guer.
deplanata, Uhl.
Galgulus oculatus, Fab.
Naucoris poeyi, Guer.
Belostoma americanum, Leidy. (?)
Zaitha fluminea, Say.
Ranatra quadridentata, Stal.
Nepa apiculata, Harris. (?)
Notonecta undulata, Say.
sp., indet.
Anisops platycnemis, Fieb.
Corixa alternata, Say.
n. sp., Uhler.

HEMIPTERA-HOMOPTERA.

Cicada septendecim, Linn.
parvula, Say.
four sps., indet.
Ceresa diceros, Say.
bubalus, Fab.
Stictocephala festina, Say.
Enchenopa binotata, Say.
Campylonchia curvata, Fab.
Ophiderma mera, Say.
Heliria cristata, Fairm.
Telamona securicula, Uhl.
unicolor, Fitch.
jugata, Uhl.
querci, Fitch,
querci, Fitch, var.
fasciata, Fitch, var.
Amphiscopa bivittata, Say.
Ormenis pruinosa, Say.
Aphrophora quadrangularis, Say.
Nersia curviceps, Stal.
sp., indet.
Penthimia americana, Walker.
Scolops spurcus, Uhl.
sulcipes, Say.
dessicatus, Uhl.
three sps., indet.
Liburnia gothica, Uhl.
Cixius sp., indet.
Delphax tricarinatus, Say.
consimilis, Uhl.
Proconia undata, Say.
Diedrocephala mollipes, Say.
coccinea, Frost.
Tettigonia versabilis, Uhl.
hieroglyphica, Say.
Cicadula exitiosa, Uhl.
sp., indet.
Stenocladus unicolor, Fitch.

Allygus irroratus, Say.
Scaphoideus immistus, Say.
Thamnotettix aurora, Uhl.
sp. indet.
Agallia siccifolia, Uhl.
Bythoscopus sp., indet.

MANHATTAN, KAS., November 21, 1884.

Gypona octolineata, Say.
columba, Fitch, var.
sp., indet.
Jassus seminudus, Say.
Erythroneura, two species.
Celidia subbifasciata, Say.

ON SOME SALT MARSH COLEOPTERA.

BY WARREN KNAUS, SALINA, KANSAS.

The salt marshes of Kansas are characterized by an insect fauna that is, usually, peculiarly their own. They are of especial interest to the entomologist, for here he finds forms closely allied to those taken on the ocean shore—the Atlantic, or Gulf of Mexico. The coleopterist who has made marine forms a special study, can with reasonable accuracy tell what species will be found on the saline deposits of the Mississippi valley. As an illustration of this, Mr. Henry Ulke, of Washington, D. C., writes me that he predicted to a correspondent that *Cicindela togata*, then taken on the coast near Corpus Christi, Texas, would be found on the salt flats in the vicinity of Lincoln, Neb.; a few weeks afterward his prediction was verified.

Each season for the last four years, I have collected *Cicindelidæ* on a salt marsh near Fredonia, Wilson county. In the summer of 1880 I visited this locality for the purpose of procuring specimens of the saline incrustations, to be analyzed. While walking across the bare surface of a lateral offshoot of the marsh, a tiger beetle ran from before me; a stroke of my hat disabled it and made its capture easy. This specimen, when identified, proved to be *Cicindela circumpicta* Laf., a comparatively rare species, and never before, I believe, taken so far east.

In 1881 I visited this locality the last week in June, and found the same beetle in abundance. A large number of specimens were taken, and they did not disappear until the last week in July.

The season of 1882 they were observed about the same time—*i. e.*, from the last week in June until the last week in July.

The season of 1883 was about two weeks later than the preceding season, and I took, in company with my friend Mr. S. C. Mason, sixty specimens on the afternoon of August 6th.

The present season this handsome beetle was very abundant; one hundred and thirty-five specimens being taken July 12th in two hours' work with the use of a single net. Ten days later many of them had disappeared, only one hundred specimens being taken in an afternoon's work.

Two varieties occur in almost equal abundance with the typical form—one with blue elytra, and one with bronze elytra and thorax. This beetle is found more abundant near the water's edge, where the bare saline ground is moist and warm, and in sheltered offshoots, where the sun shines the hottest.

In the same locality *Cicindela punctulata* Fabr. is also found mingled with *Cicindela circumpicta*, but their occurrence is rare in comparison with the latter species.

Cicindela euprascens Lec., is given by Professor E. A. Popenoe in his "Preliminary List of Kansas Coleoptera," as occuring at Lawrence, Topeka, Hutchinson, and in Rooks county, on "sand bars and banks of streams." In August, 1882, Mr. S. C. Mason found this species in great abundance on a sand bar at the mouth of a small stream which emptied

into the Solomon river below the "Great Spirit spring." He easily took a number of specimens without the aid of a net. It is very probable that one or two closely-allied species also frequented this congenial saline haunt.

While collecting *Cicindela circumpicta* on the salt marsh at Fredonia this season, I took a single specimen of *Cicindela cuprascens*, and the only one I have ever observed in southeast Kansas.

In the summer of 1883 Mr. A. W. Jones, of Salina, Kansas, gave me two specimens of *Rhyssemus*. Afterward I took a few specimens by sifting leaves and decaying vegetation. Mr. Ulke, to whom a specimen was submitted for determination, says: "This is a veritable salt insect; a similar one (*Rhyssemus scaber*) was discovered by me on the ocean shore in Maryland." This species has not been described as yet, and is probably peculiar to saline localities.

A thorough investigation of the coleopterous inhabitants of the saline localities in Kansas will undoubtedly reveal many species not known to the State, and intimately connected with the saline and maritime forms of the southern and eastern coasts of the Atlantic ocean and the Gulf of Mexico.

LISTS OF LEPIDOPTERA AND COLEOPTERA COLLECTED IN NEW MEXICO BY THE KANSAS UNIVERSITY SCIENTIFIC EXPEDITIONS OF 1883 AND 1884.

BY PROF. F. H. SNOW, OF THE UNIVERSITY OF KANSAS.

The following lists may be considered as supplementary to the lists published in vol. VIII of these Transactions, and include only those species which were not embraced in those lists. In July and August, 1883, our collections were made in the same locality as 1882—the Gallinas cañon, near the Las Vegas Hot Springs. My assistants were Messrs. L. L. Dyche, W. H. Brown, W. C. Stevens, and W. A. Snow. In August, 1884, the same individuals composed the party, which was divided into two sections. The first section made collections in the same locality as in the two preceding years, while the second section visited the southwestern corner of New Mexico, and encamped about twelve miles north of Silver City, on the Walnut creek, some three miles west of the divide which separates the Atlantic and the Pacific slopes. Here were found a considerable number of forms previously known to occur only in Arizona and old Mexico. Acknowledgments are due to Mr. W. J. Howard, of Silver City, for many favors; to Dr. Geo. H. Horn, for determinations of Coleoptera; and to Messrs. Henry Edwards, B. Neumoegen and J. B. Smith, for similar favors in the Lepidoptera. The letter appended to each species gives the locality of collection—G. and W. indicating, respectively, Gallinas cañon and Walnut creek cañon.

LIST OF LEPIDOPTERA.

Papilio philenor L. W.
Limenitis ursula Fab. var. Arizonensis Edw. W.
Thecla halesus Cram. W.
Thecla læta Edw. W.
Lycæna alce Edw. W.
Lycæna marina Edw. W.
Lycæna neglecta Edw. W.
Amblyscirtes ænus Edw. W.
Pholisora, n. sp. W.
Thanaos pacuvius Lintn. W.
Pamphila lunus Edw. W.
Eudamus moschus Edw. W.
Eudamus cellus Bd.–Lec. W.
Hemaris diffinis Boisd. W.
Everyx sp. (faded). W.
Sphinx elsa Strk. Silver City.
Alypia Grotei Bois. (Alypiodes flavinguis Gr.) W. and G.
Copidryas Gloveri G. and R. W.
Hypoprepia cadaverosa Strk. W.
Crocota ostenta Hy. Edw. W.

Crocota Treatii Gr. G.
Daritis sp. A superb species obtained from Mr. W. J. Howard, Silver City.
Nemeophila var. hospiton S. V. G.
Halisidota pura Neum. Silver City.
Euchaetes vivida Gr. (?) W.
Cerura occidentalis Lintn. W.
Platysamia Gloveri Strk. From Mr. W. J. Edema n. sp. Howard, Silver City.
Ichthyura inornata Neum.
Clisiocampa incurva Hy. Edw. G.
Hepialus Behrensii var.montanus Stretch. G.
Acronycta perdita.
Agrotis rufula Smith n. sp. G.
Agrotis ferruginoides Smith n. sp. G.
Agrotis flavidens Smith n. sp. G.
Agrotis vocalis Gr. W.
Agrotis redimicula Gr. W.
Agrotis verticulis Gr. W.
Mamestra prodeniformis Smith n. sp. W.
Mamestra n. sp. (not yet described.) W.
Mamestra laudabilis Guen. W.
Mamestra Farnhami Gr. W.
Hadena impulsa Morr. W.
Pseudanarta crocea Hy. Edw. W.
Gortyna serrata Gr. W. and G.
Amphipyra glabella Morr. W.
Orthodes infirma Guen. W.
Calymnia orina Guen. G.
Calymnia orina var. G.
Plusia Ni Hübn. W.
Plusia gamma L. W.
Plusia Sackenii Gr. G.
Plusia Snowi Hy. Edw. n. sp. G.
Anarta promulsa Morr. W.
Stibadium sp. G.
Stiria nanata Neum. n. sp. G.
Polenta Tepperi Morr. G.
Antaplaga dimidiata Gr. G.
Melicleptria villosa Gr. G.
Heliothis suavis Hy. Edw. G.
Anthœcia tumida Gr.
Cirrophanus triangulifer Gr. G.
Charicleа pernana Gr. W.
Melipotis pallescens G. and R. W.
Catocala neogama Ab. and Sm. W.
Catocala Arizonæ Gr. W.
Phegarista sevorsa Gr. W.
Trama arrosa Harvey.
Tetracis indiscretata Hy. Edw. n. sp. G.
Caberodes confusaria Hübn. G.
Snowia montanaria Neum. n.g. and n.sp. G.
Azelina Hubneraria Guen. var. W.
Antepione imitata Hy. Edw. n. sp. G.
Synchlora rubrifrontaria Pack. G.
Chlorosea Nevadaria Pack. G.
Acidalia enucleata Guen. G.
Semiothisa præatomaria Harv. var. G.
Semiothisa enotata Guen. G.
Thamnonoma tripunctaria Pack. G.
Mesographe rimosalis Guen.
Desmia maculalis Westn. W.
Desmia subdivisalis Gr. G.
Crambus Leachellus Zinck. G.

LIST OF COLEOPTERA.

(The numbers prefixed are those of Crotch's and Austin's Check Lists.)

37a. *Cicindela* imperfecta Lec. G.
64. *Cicindela* lemniscata Lec. Deming.
72. *Omophron* americanum Dej. W.
116. *Nebria* obliqua Lec. G.
118. *Nebria* hudsonica Lec. W.
119. *Nebria* Sahlbergi Fisch. G.
279. *Schizogenius* depressus Lec. W.
303. *Brachynus* Tschernikhii Mann. W.
——. *Brachynus* n. sp. W.
334. *Lachnophorus* pubescens Dej. W.
——. *Lebia* scapula Horn. W.
356. *Lebia* analis Dej. var. W.
412. *Pinacodera* punctigera Lec. W.
——. *Callida* platynoides Horn. W.
434. *Calathus* advena Lec. W.
453. *Platynus* bicolor Lec. W.
523. *Platynus* bembidioides Kirby. G.

524. *Platynus* octocolus Mannh. G.
562. *Evarthrus* constrictus Say. W.
7522. *Pterostichus* longulus Lec. G.
699. *Amara* fallax Lec. W.
705. *Amara* lævipennis Kirby. G.
761. *Chlænius* ruficauda Chaud. W.
788*a*. *Chlænius* obsoletus Lec. W.
875. *Anisotarsus* maculicornis Chaud. W.
1015. *Trechys* chalybeus Mann. W.
——. *Bembidium* n. sp. W.
——. *Bembidium* (near) tetraglyptum Mann. W.
——. *Tachys* (near) tripunctatus Say. W.
1325. *Rhantus* atricolor Aubé. W.
1735. *Bryoporus* testaceus Lec. W.
1760. *Quedius* hyperboreus Er. G.
1766. *Quedius* molochinus Grav. G.
1778. *Staphylinus* mysticus Er. W.
1779. *Staphylinus* comes Lec. W.
——. *Philonthus* quadrulus Horn. W.
——. *Lithocaris* n. sp. W.
——. *Conosoma* sp. W.
——. *Deliphrum* brevicolle. G.
——. *Choleva* basillaris. W.
2248. *Liodes* globosa Lec. W.
2595. *Pediacus* fuscus Er. G.
2659. *Rhizophagus* dimidiatus Mann. W.
2749. *Epurœa* truncatella Mann.
2795. *Pityophagus* rufipennis Horn. W.
8054. *Pityophagus* verticalis Horn. G.
——. *Orthopeplus* quadricollis Horn. W.
2819. *Olibrus* nitidus Mels. W.
2834. *Hippodamia* oregonensis Cr. W.
——. *Byrrhus* n. sp. W.
2957. *Byrrhus* concolor Kirby. W.
3235. *Copris* moechus Lec. W.
——. *Phanæus* quadridens Say. W.
——. *Aphodius* n. sp. W.
3287. *Aphodius* consentaneus Lec. var. W.
3340. *Ochodæus* striatus Lec. W.
3432. *Serica* serotina Lec. W.
3437. *Serica* curvata Lec. W.
3484. *Diplotaxis* haydenii Lec. G.
——. *Diplotaxis* n. sp. W.
——. *Diplotaxis* not named. W.
——. *Lachnosterna* longipilis Horn. W.
——. *Lachnosterna* n. sp. (near ephelida.) W.
——. *Phytalus* debilis Horn. W.
3588. *Strigoderma* arboricola Fabr. W.
3605. *Cyclocephala* manca Lec. W.
3619. *Aphonus* clunalis Lec. W.
——. *Orizabus* Snowi Horn. n. sp.

3621. *Xyloryctes* satyrus Fab. var. W.
3637. *Gymnetis* cretacea Lec.
——. *Euphoria* sp.
3795. *Acmæodera* culta Web. G.
8203. *Acmæodera* amabilis Horn. W.
8209. *Acmæodera* miliaris Horn. W.
3929. *Chalcolepidius* Webbii Lec. W.
4031. *Elater* nigrinus Payk. G.
4035. *Elater* pullus Cand. G.
4172. *Melanotus* paradoxus Mels. W.
4317. *Corymbites* aeripennis Kirby. W.
4373. *Sandalus* Californicus Lec. W.
4419. *Lyeus* cruentus Lec. W.
——. *Lycostomus* loripes Chevr. W.
——. *Lycostomus* Fernandezi. W.
4430. *Eros* aurora Hbst. W.
8306. *Podabrus* lateralis Lec. G.
4709. *Cymatodera* cylindricollis Chev. W.
4711. *Cymatodera* puncticollis Bland. W.
4722. *Clerus* Spinolæ Lec. W.
4738. *Clerus* mœstus Kluy. G.
4758. *Hydnocera* discoidea Lec. W.
——. *Ernobius* n. sp. W.
4837. *Trypopitys* sericeus Say. W.
4866. *Ptilinus* ruficornis Say. W.
4905. *Spondylis* upiformis Mann. W.
4939. *Tetropium* cinnamopterum Kirby. G.
4958. *Phymatodes* dimidiatus Kirby. G.
4960. *Callidium* antennatum Newm. W.
4998. *Elaphidium* procerum Lex. W.
——. *Stenosphenus* sp. W.
5062. *Dendrobias* quadrimaculatus Dup. Deming.
5165. *Stenocorus* lineatus Oliv. G.
5180. *Pachyta* liturata Kirby. G.
5277. *Leptura* nigrolineata Bland. G.
5348. *Leptostylus* biustus Lec. W.
5534. *Orsodacha* atra Ahr. W.
5538. *Zeugophora* abnormis Lec. G.
5561*b*. *Babia* tetraspilota Lec. W.
8452. *Diachus* auratus Fab. W.
8482. *Cryptocephalus* amatus Hald. W.
8517. *Pachybrachys* subvittatus Lec. G.
5629. *Pachybrachys* Xanti Cr. (?) W.
5660. *Pachybrachys* abdominalis Say. var. W.
5731. *Chrysomela* continua Lec. G.
——. *Calligrapha* multiguttis Stähl. W.
5765. *Plagiodera* Arizonæ Cr. W.
5788. *Luperus* varicornis Lec. W.
5837. *Trirhabda* convergens Lec. G.
——. *Octosoma* marginicollis Horn. W.
5956. *Odontota* omogera Cr. W.

8590. *Odontota* collaris Say. W.
——. *Charistena* n. sp. W.
——. *Microrhopala* vulnerata Horn. W.
6226. *Bius* estriatus Lec. W.
——. *Allecula*, two species. W.
6329. *Corticeus* parallelus Mels. G.
6459. *Notoxus* bifasciatus Lec. W.
6550. *Carebara* longula Lec. G.
6566. *Enstrophus* indistinctus Lec. W.
8626. *Helops* arizonensis Horn. W.
6716. *Macrobasis* ochrea Lec. W.
6781. *Cantharis* deserticola Horn. W.
8705. *Nemognatha* punctipennis Lec. W.
8830. *Tanymecus* lacæna Hbst. W.
——. *Acmæogenius* sp. W.
8844. *Phaccpholis* candida Horn. W.
8946. *Cleonopsis* pulvereus Lec. W.
8985. *Procas* Lecontei (picipes Steph.) W.
9084. *Anthonomus* quadrigibbus Say. W.
——. *Cryptorhynchus* sp. W.
——. *Baris* sp. W.
9422. *Rhodobænus* pustulosus Gyll. W.
9519. *Pityophthorus* puncticollis Lec. W.
——. *Pityophthorus* n. sp. W.
9535. *Xyloterus* bivittatus Hb. G.
9546. *Xyleborus* xylographus Say. W.
9620. *Dendroctonus* similis Lec. W.
9623. *Dendroctonus* simplex Lec. G.
——. *Hylurgops* sp. W.

In connection with the preceding list it may be interesting to note that the season was a very dry one, there being hardly enough rain, except on one occasion, to thoroughly wet the canvas of our tent in the Walnut creek cañon during a stay of five weeks. The bed of the creek was dry for long distances. Collecting "at sugar" was rewarded by very indifferent success. Some fine beetles and moths were taken "at light," by making huge fires of pitch-pine logs. Among these were *Plusiotis gloriosa*, *Plusiotis Lecontei*, *Orizabus Snowi*, *Strategus cessus*, *Aphonus clunalis*, and *Cyclocephala manca*. *Lachnosterna longipilis* was taken at dusk while flying about the foliage of the live-oaks. The only specimen taken of *Chalcolepidius Webbii* was a large female resting upon an old pine stump. The electric lights at Silver City were very attractive to insects. Here were taken *Sphinx Elsa*, *Halisidota pura*, *Smerinthus occidentalis*, a magnificent *Daritis*, *Dynastes Grantii*, and other fine species of both Lepidoptera and Coleoptera. *Dendrobias quadrimaculatus*, *Clerus Spinolæ*, and *Macrobasis ochrea* were found abundantly upon the blossoms of the tall species of yucca in the vicinity of Deming and Silver City.

PRELIMINARY LIST OF KANSAS FISHES.

MR. PRESIDENT: The following preliminary list of the fishes of Kansas is submitted as a part of the report of your Commission on Ichthyology. My thanks are due and are hereby expressed to Professor (now President) David S. Jordan, of Indiana State University, the well-known authority on the fresh-water fish fauna of North America, for his

kindly assistance and suggestions. The list here presented has passed through his hands, and the synonomy and nomenclature are corrected to date, thus making this list correspond in these particulars with President Jordan's Catalogue of the Fishes of North America, soon to be issued by the United States Fish Commission.

Also, Hon. W. S. Gile, State Fish Commissioner, has furnished much valuable information in reference to the native food fishes of the State, as well as to the work of the Commission, for which thanks are expressed.

The fish fauna of the Arkansas river is but little known, and offers a large field for the investigator. The fauna is known to be large, and the few specimens known from that stream are withheld from the list of Kansas fishes until opportunity offers for their careful study.

Of the fish planted in Kansas waters by the State Fish Commission, several kinds foreign to our waters, are known to be increasing in size and numbers; though it would be manifestly inaccurate to place all of them on the list of Kansas fishes, without further knowledge. Respectfully submitted.

I. D. GRAHAM, Chairman,
State Agricultural College.

Class MARSIPOBRANCHII.

Order HYPEROARTIA.

Family *Petromyzontidæ.*

Genus Ammocetes, Duméril.

A. niger Rafinesque. Small Black Lamprey. One specimen found attached to a "red-horse" from Wild Cat creek, near Manhattan. Length of specimen about 6 inches. (*Petromyzon nigrum* Raf., Ich. Oh. 84, Jordan 349.)

Genus Petromyzon, Linnæus, 1758.

P. argenteus, Kirtland. Silvery Lamprey. Cottonwood river. (*Petromyzon argenteus* Kirt., Bost. Jour. Nat. Hist., 1840. *Ichthyomyzon hirudo* Grd., Pac. R. R. survey.)

Class PISCES.

Order SELACHOSTOMI.

Family *Polyodontidæ.*

Genus Polyodon, Lacepede.

P. spathula, Walbaum. Paddle Fish, Spoon-bill Cat, Duck-bill Cat. A number of specimens have been taken from the Kansas river at Manhattan, one of which (a poor specimen) is now in the museum of the State Agricultural College. (*Squalus spathula*, Walbaum, Artedi Pisc, 1792. *Polydon feuille* Lacepede, Hist. Nat. Poiss. *Polyodon folium*, Schneider, Blach. Syst. Ich., etc.)

Family *Acipenseridæ.*

Genus Scaphirrhynchops, Gill.

S. platyrrhynchus, Rafinesque. Shovel-nosed Sturgeon, Shovel Fish, Paddle Fish, Hacklebach. Common over State. (*Acipenser platorhynchus* Raf., Ich. Oh. 1820. *Scaphirhynchus catapractus* Günther.)

Genus Acipenser, Linnæus.

A. rubicundus, Le Sueur. Black Sturgeon, Stone Sturgeon, Rock Sturgeon, etc. Kansas river. (*Acipenser rubicundus, maculosus* and *liopeltis* Günther; also Milner in Rept. U. S. Fish Com., 1872–73.)

Order GINGLYMODI.

Family *Lepidosteidæ.*

Genus Lepidosteus.

L. osseus (L.) Agassiz. Gar Pike, Long-nosed Gar, Bill-fish, etc. Common in all streams. (*Esox osseus*, Linn. Syst. Nat. *Lepidosteus oxyurus* Raf., Oh. Ich.)

L. platystomus Rafinesque. Short-nosed Gar, Duck-billed Gar, etc. Kansas river. Not so common as the preceding. (*Lepisosteus platostomus* Rafinesque, Ich. Oh.)

Order HALECOMORPHI.

Family *Amiidæ*.

Genus Amia, Linnæus.

A. calva, Linn. Mud Fish, Dog Fish, Bowfin, Grindle, John A. Grindle, Lawyer. Branches of Missouri river, Osage river, etc. (Linn. Syst. Nat. *Amia Occidentalis* De Kay. New York Fauna Fish.)

Order NEMATOGNATHI.

Family *Siluridæ*.

Genus Noturus, Rafinesque.

N. miurus, Jordan. A Stone Cat. Branches Missouri river. (Nat. Hist. New York, 1877.)

N. flavus, Rafinesque. Common Stone Cat. (Raf., Am. Month. Mag., 1818.)

N. gyrinus, Mitchell. Yellow Cat, Stone Cat. (*Silurus gyrinus* Mitchell, Amer. Month. Mag., 1818.)

N. exilis, Nelson. Stone Cat. Common in Neosho, Osage, etc. (Nelson, Bull, Ill. Mus. Nat. Hist., 1876.)

Genus Leptops, Rafinesque.

L. olivaris, Raf. Mud Cat, Yellow Cat, Bashaw, Goujon. Kansas river. (*Hopladeus olivaris*, Gill. Ichth. Capt. Simpson's Expl. 1776. *Pelodichthys olivaris* Jordan.)

Genus Amiurus, Rafinesque.

A. vulgaris, Thompson. A Bull-head. (*Pimelodus vulgaris* Thompson, Hist. of Vermont, 1842. *P. ailurus* Girard, U. S. Pac. R. R. Expl. Fish, 1858.)

A. melas (Raf.), Jordan and Copeland. Black Bull-head, Small Black Cat, Bull-head. Appears to be common over the State. Reported in the Washburn Bulletin of Natural History as A. eragini, Gilbert, a new species. (*Silurus melas* Raf., Quart. Jour. Sci., Lit., Arts., Lond., 1820. *Pimelodus catulus*, Girard, Pac. R. R. Surv., 1858. *Amiurus obesus* Gill., Bost. Nat. Hist. Soc., 1862.)

A. natalis, LeSueur, var. Cupreus. Yellow Cat. Kansas and Neosho rivers. (*Pimelodus natalis* LeS., Mem. Mus., 1819. *P. felinus et antoniensis* Girard, Pac. R. R. Expl.)

A. nigricans (LeS.), Jordan. Great Fork-tailed Cat, Mississippi Cat, Flannel-mouth Cat, Florida Cat. One of the largest of the catfishes, reaching a weight of 100 pounds or more. (*Gadus acustris* Walbaum, Artedi Pisc. 1792. *Amiurus borealis* Günther. *Pimelodus nigricans* LeS., Mem. Mus. 1819.)

A. nebulosus, LeSueur. Bull-Head, Horned Pout, Small Catfish, Schuylkill Cat, Sacramento Cat. Plentiful. This is the *A. catus* Linn. of the synopsis of the Fishes of N. A. by Jordan and Gilbert. (*Silurus catus* Linn., Syst. Nat. 1758. *Pimelodus nebulosus* LeS., Mem. Mus. 1819.)

Genus Ictalurus, Rafinesque.

I. punctatus (Rafinesque) Jordan. Silver Cat, Blue Cat, Channel Cat, White Cat. Quite common, and much prized as a food fish. (*Silurus punctatus* Raf., Amer. Month. Mag., 1818. *Ictalurus beadlei* and *Simpsoni* Gill. *Ichthælurus robustus* Jordan.)

I. furcatus (Cuv. & Val.) Gill. Spotted Channel Cat. Not so common as preceding. Larger streams. (*Pimelodus furcatus* Cuv. & Val., 1840. *Amiurus furcatus* Günther & Jordan.)

Order PLECTOSPONDYLI.

Family *Catostomidæ*.

Genus Ictiobus, Rafinesque.

I. carpio (Rafinesque), Jordan. Carp Sucker. Kansas river. Plentiful. (*Catostomus carpio* Raf., Ich. Oh., 1820. *Carpiodes nummifer* Cope, Proc. Amer. Phil. Soc. Phila., 1870.)

I. velifer, Rafinesque. Buffalo Fish, Quillback, Spear Fish, Sail Fish, Skimback. "Eureka lake," (Kansas river.) (*Catostomus velifer* Raf., Ich. Oh., 1820. *I. velifer* Jordan, 1884.)

I. velifer var. bison, Agassiz. Same locality as above. Less common. (Agassiz Amer. Jour. Sci. Arts, 1854, as *Carpiodes bison.*)

I. urus, Agassiz. Mongrel Buffalo. Kansas river and branches of Missouri. (*Carpiodes urus.* Ag. Amer. Jour. Sci. Arts, 1854.)

I. bubalus (Raf.), Agassiz. Common Buffalo. Plentiful over State. (*Amblodon bubalus*, Raf. Jour. Phys., 1818. Agassiz Am. Jour. Sci. Arts, 1854. *I. bubalus*, Jordan, Bull, U. S. Nat. Mus.)

I. cyprinella (C. and V.) Ag. Jordan. Red-mouthed Buffalo, Big-mouth Buffalo. Streams of Eastern Kansas. (*Sclerognathas cyprinella* C. and V., Hist. Nat. Poiss., 1844.)

Genus Cycleptus, Rafinesque.

C. elongatus (LeS.), Ag. Black-horse, Gourd-seed Sucker, Missouri Sucker, Suckerel. Kansas river. A remarkable fish; not plentiful. (*Castotomus elongatus* LeS., Journ. Acad. Nat. Sci. Phila., 1817.)

Genus Catostomus, LeSueur.

C. teres, Mitchell. Common Sucker, White Sucker, Brook Sucker, Fine-scaled Sucker. Common over State. Is the *C. commersoni* of Synopsis. (*Cyprinus teres* Mitchell, Lit. and Phil. Soc. N. Y., 1814. *Catostomus teres*, Günther; also Jordan.)

C. nigricans, Le Sueur. Hog Sucker, Stone Roller, Toter, Crawl-a-bottom, Hammerhead, Stone Lugger, Hog Molley. Common; Kansas and Neosho rivers. (LeS. Jour. Acad. Nat. Sci., Phila., 1818. *Hylomyzon nigricans* Agassiz, Am. Jour. Sci. Arts, 1855.)

Genus Erimyzon, Jordan.

E. sucetta (Lac.), Jor., var. oblongus, Jor. Creek Fish, Chub Sucker, Sweet Sucker. Neosho and branches; common. (*Cyprinus succeta* Lac., Hist. Nat. Poiss., 1803. *Catostomus gibbosus* Storer, Fish Mass.; Jordan, Man. Vert.)

Genus Minytrema, Jordan.

M. melanops (Raf.), Jordan. Spotted Mullet, Striped Sucker, Mingo Sucker. Common in the Neosho. (*Catostomus melanops.* Raf. Ich. Oh., 1820. *C. faseiatus* Jordan, Man. Vert.)

Genus Moxostoma, Rafinesque.

M. macrolepidotum, LeSueur. Common Red-horse, Mullet, White Sucker, Large-scaled Sucker. Plentiful. (*Catostomus macrolepidotus* and *duquesni* LeSueur, Jour. Acad. Nat. Sci. Phila., 1817. *Myxostoma macrolepidota*, and vars. *duquesni* and *lachrymalis* Jordan, Man. Vert. and Jordan Bull. U. S. Nat. Mus.)

M. aureolum (LeS.) Jordan. Red-horse. Not common. (*Catostomus aureolus* LeSueur, Jour. Acad. Nat. Sci. Phil., 1817. *C. macrolepidotus* Jordan, Man. Vert.)

Family *Cyprinidæ.*

Genus Campostoma, Agassiz.

C. anomalum (Raf.), Agassiz. Stone-roller, Stone-lugger. Common in small streams. (*Rutilus anomalus* Raf. Ich. Oh., *Campostoma callipteryx, mormyrus, gobionium*, and *hippops* Cope, Proc. Acad. Nat. Sci. Phila., 1864.)

Genus Chrysomus, Rafinesque.

C. erythrogaster, Agassiz. Red-bellied Dace. Marais des Cygnes river. (*Chrosomus erythrogaster.* Raf., Ich. Oh., 1820.)

Genus Hybognathus, Agassiz.

H. placita, Girard. "A rare species. This specimen agrees with Girard's type."—JORDAN. Kansas river and other branches of Missouri. (Girard, Proc. Acad. Nat. Sci. Phila., 1856.)

H. nuchalis, Agassiz. Silvery Minnow. (Agassiz, Amer. Jour. Sci. Arts, 1855. *Hybognathus argyritis*, Jordan.)

Genus Dionda, Girard.

D. Meeki, Jordan and Gilbert. A Silvery Minnow. Neosho river. (Jordan, 1884.)

Genus Pimephales, Rafinesque.

P. promelas, Raf. Flat-Head, Black-Head Minnow. (Raf. Ich. Oh.) P. promelas *var.* confertus Girard. Kansas river. (*Hyborhynchus confertus* (?) and *Pimephales maculosus* (?) Girard, Proc. Acad. Sci., 1856.)

P. notatus (Raf.), Agassiz. Blunt-Nosed Minnow. (*Minnilus notatus* Raf., Ich. Oh. and *Catostomus melanolus* Raf., Ich. Oh.)

Genus Cliola, Girard.

C. vigilax, B. & G. Silver Fin. This is the only species in this genus. (*Ceratichthys vigilax*, Baird & Girard, Proc. Acad. Nat. Sci. Phila., 1853. *Cliola vigilax*, *velox* and *vivax*, Girard in same and in Pac. R. R. Sur.)

Genus Notropis, Rafinesque.

"This genus now takes the place of *Cliola* and *minnilus* in the Synopsis of Fishes of North America."—JORDAN.

N. hudsonius, Jordan. Spawn Eater. "Not hitherto known from west of Lake Michigan. Color darker and gape wider than in Eastern specimens. Perhaps a geographical variety."—DR. JORDAN. Kansas river branches. (*Clupea hudsonia*. De Witt Clinton, Ann. Lyc. Nat. Hist. N. Y., 1824. *Hudsonius fluviatilis* Girard, Proc. Acad. Sci. Phila. 1856.)

N. billingsiana (Cope), Jordan and Gilbert. "Dedicated to Joshua Billings, Esq., author of original observations on 'The Briny Codfish.'" Kansas river and Missouri river at St. Joseph. (*Cyprinella billingsiana* Cope. Hayden's Geol. Sur. Ter. Wyoming, 1870, 1872.)

N. megalops, Rafinesque. Shiner, Red-fin, Dace, etc. Given as *minnilus cornutus*. Mitchell in the Synopsis of Fishes of N. A.

N. camurus, Jordan and Meek. Silver Fin. Neosho river and Western Missouri. (*Cyprinella Whipplei* Girard, Proc. Acad. Sci. Phila. 1856, and Pac. R. R. Surv. X. 270.)

N. lutrensis, Jordan. "This species takes the place of *Cliola forbsei, gibbosa, pulchella, iris, jugalis, gracilis*, etc., of the Synopsis."—D. S. JORDAN. Very abundant.

N. lineolatus, Agassiz. This is the *Cliola lincolata* Ag., of the Synopsis. Marais des Cygnes river.

N. bubalina (Girard), Jordan and Gilbert. Is the *Cliola umbrosa* Grd., of Synopsis. (*Cyprinella umbrosa* Girard, Proc. Acad. Nat. Sci. Phila., 1856, and Pac. Rld. Surv. X, 266.)

N. deliciosa, Girard. Straw-colored Minnow. Is the *Cliola Missuriensis* Cope, of the Synopsis. Somewhat common in Kansas river branches. (Hayden's Geol. Surv., Wyoming, 1870–72, *Hybopsis Missuriensis* Cope.)

N. topeka, Gilbert, sp. nov. A new species, discovered by Prof. F. W. Cragin, of Washburn College, Topeka, and published in the Bulletin of the Washburn Natural History Survey of Kansas; also taken by Prof. D. S. Jordan in Missouri river at St. Joseph, in August, 1884.

N. rubifrons (Cope), Jordan. Rosy-faced Minnow. Kansas and Missouri rivers. A beautiful species. (*Alburnus rubifrons* Cope, Proc. Acad. Sci., Phila., 1865. *Notropis rubifrons*, Jordan, 296.)

N. umbratilis (Girard), Jordan. This is the *Minnilus nigripinnis* Gilbert, given as a new species in his notes in the Bulletin Washburn Natural History Survey. (*Alburnus umbratilis* Grd. Proc. Acad. Sci., Phila., 1856. *Alburnellus umbratilus* Grd. Pac. Rld. Surv., X, 260.)

N. zonatus, Jordan. Is the *Alburnus zonatus* of Agassiz, and is reported from branches of the Missouri, and the Neosho river. (*Alburnus zonatus* Putnam, Bull. Mus. Comp. Zöol., 1863. *Photogenis piptolepis* Cope, Hayden's Geol. Surv. Wyoming, 1870.)

N. dilectus (Cope), Jordan. Inserted on authority of Prof. Cope. (*Alburnus oligaspis* Cope, Proc. Acad. Sci., Phila., 1864.)

Genus Phenacobius, Cope.

P. mirabilus (Girard), Jordan. Common throughout the State. (*Exoglossum mirabile* Girard, Proc. Phila. Acad. Sci., 1856, and Pac. Rld. Surv., X, 256. *Sarcidium scopiferum* Cope, Hayden's Geol. Surv. Terr. Wyoming, 1870, 1872. Jordan, Bull. Hayden's Geol. Surv. Terr., IV, No. 3, 666.)

Genus Hybopsis, Agassiz.

H. biguttatus (Kirt), Girard. Hornyhead, River Chub, Jerker. This is the *Ceratichtheys biguttatus* Kirt, of the Synopsis. Very common. (*Semotilus biguttatus* Kirt, Bost. Jour. Nat. Hist., 1840, etc.)

H. amblops (Raf.), Girard. Silver Chub. Neosho river. (*Rutilus amblops.* Raf. Ich. Oh., 1820. *Hybopsis gracilus* Agassiz, Proc. Amer. Jour. Sci. Arts, 1854.)

H. gelidus (Girard), Jordan. A small specimen; length 2 inches. Branches of Missouri river. (*Gobio gelidus* Girard, Proc. Acad. Sci., Phila., 1856, and Pac. Rld. Surv., 248.)

H. storerianus, Jordan. Is the *Ceratichthys lucens* Jordan, of the Synopsis. Osage river and branches.

Genus Platygobio, Gill.

P. gracilis (Rich.), Gill and Jordan. Flat-headed Chub. Kansas river. (*Cyrinus* [*Leuciscus*] *gracilis*, Rich., Fauna Bor. Amer. Pisc., 1836. *Pogonichthys communis* Girard, Proc. Acad. Sci., Phila., 1856, and Pac. Rld. Surv., X, 247.)

Genus Semotilus, Rafinesque.

S. atromaculatus, Mitchell. Chub, Horned Dace. Is the *S. corporalis* (Mitch.), Putnam, of the Synopsis.

Genus Gila, Baird and Girard.

G. affinis, Abbott. "Kansas river." Abbott and Jordan. (Abbott, Proc. Acad. Sci., Phila., 1860.)

Genus Notemigonius, Rafinesque.

N. chrysoleucus (Mitch.), Jordan. Golden Shiner, Bream. Eastern Kansas. (*Cyprinus chrysoleucus*, Mitch., Rept. Fish. N. Y., 1815. *Abramis americanus* Günther, Jordan, Bull. U. S. Nat. Mus.)

Family *Atherinidæ*.

Genus Labidesthes, Cope.

L. sicculus, Cope. Brook Silverside, Skipjack. Neosho river. Common. (*Chriostoma sicculum* Cope, Proc. Acad. Sci. Phila., 1865. *Labidesthes sicculus* Cope, Proc. Amer. Phil. Soc., 1870.)

Family *Cottidæ*.

Genus Uranidea, DeKay.

U. richardsoni (Ag.) J. & G. Blob., Millers Thumb, Muffle Jaws, Bull Head. Neosho river. A widely diffused species, having many varieties. Non-migratory and varying with locality.

Family *Hyodontidæ*.

Genus Hyodon, LeSueur.

H. alosoides (Raf.) J. & G. Moon Eye. Kansas, Marais des Cygnes and Missouri rivers. (*Amphiodon alosoides* Raf., Journ. Phys. Paris, 1819. *Hyodon chrysopsis* Jordan, Bull, U. S. Nat. Mus. X. 68. *Hyodon Amphiodon* Raf., Ich. Oh., 1820.)

H. tergisus, LeSueur. Toothed Herring, Moon Eye. Common. (LeS. Jour. Acad. Sci. Phila, 1818. Jordan, Bull. U. S. Nat. Mus.)

Family *Dorosomatidæ*.

Genus Dorosoma, Rafinesque.

D. cepedianum (LeS.) Gill. Gizzard Shad, Hickory Shad. Very common and very handsome. (*Megalops cepediana* LeS., Jour. Acad. Sci. Phila., 1817.)

Family *Percopsidæ*.

Genus Percopsis, Agassiz.

P. guttatus, Agassiz. Trout Perch. Described by Gill from Kansas under the name of *Percopsis hammondi*. (Agassiz, Lake Superior, 1850. *P. hammondi* Gill, Proc. Acad. Sci. Phila., 1864.)

Family *Cyprinodontidæ*.

Genus Fundulus, Lacépede.

F. zebrinus, Jordan and Gilbert. Striped Killifish. Kansas river and branches. (Nom. sp. nov. Jordan and Gilbert, Synopsis.

F. diaphanous (LeS.), Agassiz. Spring Minnow. Kansas river. (*Hydrargyræ diaphana* LeS., Jour. Acad. Nat. Sci. Phila., 1817. *Fundulus multifasciatus* of most writers.)

Genus Zygonectes, Agassiz.

Z. notatus (Raf.), Jordan. Top Minnow. Neosho river. (*Semotilus notatus* Raf. Ich. Oh., 1820. *Zygonectes pulchellus*, Girard, Proc. Acad. Sci. Phila., 1859.)

Family *Anguillidæ*.

Genus Anguilla, Thunberg.

A. rostrata (LeS.), DeKay. Common Eel. Believed to be common throughout the State. (*Muræna rostrata* and *bostoniensis* LeSueur, Jor. Acad. Sci. Phila. *Anguilla bostoniensis* Günther, *Anguilla tyrannus* Girard, U. S. Mex. Bound Surv.)

Family *Gasterosteidæ*.

Genus Eucalia, Jordan.

E. inconstans, Kirtland. Brook Stickleback. Length, 2½ inches. Abundant northward. Described by Cope, from Kansas, as *Gasterosteus micropus*. (Kirtland, Bost. Journ. Nat. Hist., 1841. Cope, Phila. Acad. Sci. 1865. *Gasterosteus williamsoni* Girard. Pac. Rld. Surv.)

Family *Centrarchidæ*.

Genus Pomoxys, Rafinesque.

P. annularis (Raf.), Crappie; Bachelor, New Light; Campbellite, Bride Perch, Chinquapin Perch, etc. Branches Kansas river below dam at Lawrence and streams of southeast. A valuable food fish. (Rafinesque, Amer. Month. Mag., 1818. *Pomoxys storerius, brevicanda, intermedino* and *protacanthus*, Gill, Proc. Acad. Sci. Phila., 1865.)

Genus Ambloplites, Rafinesque.

A. rupestris (Raf.), Gill. Common Rock Bass, Red Eye, Goggle Eye. Another valuable pan fish, though small in size. (*Bodianus rupestris* Raf. Am. Month. Mag. 1817. *Centrarchus æneus* Jordan Man. Vert.)

Genus Chænobryttus, Gill.

C. gulosus (C. and V.), Jordan. War-mouth, Red-eyed Bream. Kansas river. (*Pomotis gulosus* C. and V. 1829. *Chænobryttus viridus* Jordan, Man. Vert. Ed. 21.)

Genus Lepomis, Rafinesque.

L. cyanellus (Raf.), Red-Eye, Blue Spotted Sunfish. Common. (Raf. Journ. de Phys., 1819. *Calliurus longulus, diaphanus, formosus*, and *microps*, Girard, Pac. Rld. Surv. and U. S. Mex. Bound. Surv. 1859. *Bryttus signifer* Grd., Pac. Rld. Surv. *Apomotis cyanellus* Jordan, Man. Vert. ed. 2.)

L. humilis (Girard), Cope. Red-spotted Sunfish. State, locally abundant. (*Bryttus*

humilis, Girard. Phila. Acad. Sci., 1857, and Pac. R. R. Surv. *L. anagallinus* Jordan, Man. Vert. ed., 2.)

L. megalotis (Raf.), Cope. Long-eared Sunfish. Neosho and branches. Common. (*Ichtelis megalotis*, Raf. Ich. Oh., 1820. *Xenotus megalotis* Jordan, Man. Vert. ed. 2. *Lepomus auritus*, Cope, Jour. Phila. Acad. Sci., 1858. *Pomotus fallax*, Girard, Pac. R. R. Surv.)

L. pallidus (Mitch), Gill and Jordan. Blue Sunfish; Dollardee, Copper-nosed Bream, common. (*Labrax pallidus*, Mitchell. Trans. Lit. and Phil. Soc. N. Y., 1815, and Jordan Man. Vert. *Pomotis luna*, Girard, Pac. R. R. Surv.)

Genus Micropterus, Lacépede.

M. salmoides (Lac.), Henshall. Large-mouthed Black Bass: Oswego Bass, Green Bass, Bayou Bass; Neosho and branches, plentiful. Reported from branches of Kansas river, below dam at Lawrence. An excellent food fish. Prefers quiet waters. (*Labrus salmoides*, Lac. Hist. Nat. Poiss., 1802. *Huro nigricans*, Günther. *Micropterus nigricans*, Gill, Proc. Amer. Asso. Adv. Sci., 1873, and of most late writers. *Dioplites nuecensis*, Girard, Mex. Bound. Surv.)

M. dolomieu, Lacépede. Small-mouthed Black Bass. The prince of good game fish. Plentiful in Neosho, Spring, and Marais des Cygnes rivers. (Lacépede, Hist. Nat. Poiss., 1802. Henshall, Book of the Black Bass, 1881. *Grystes salmonoides*, Günther.)

Family *Percidæ*.

Genus Ammocrypta, Jordan.

A. pellucida (Baird), J. & G. Sand Darter, clear sandy streams. (*Etheostoma pellucidum*, Baird's MSS. *Pleurolepis pellucidus* Jordan Man. Vert. ed. 2.)

Genus Percina, Haldeman.

P. caprodes (Raf.), Girard. Log Perch, Rock-fish, Hog-molly, Hog-fish. Eastern Kansas. The largest of the Darters; length 6 to 8 inches. (*Sciœna caprodes* Raf., Amer. Month. Mag., 1818. *Pileoma semi-fascinatum* DeKay, New York Fish Fauna, 1848. *Pileoma caprodes* Jordan, Man. Vert.)

Genus Boleosoma, DeKay.

B. olmsteadi var. maculatum, Girard. Darter. Neosho and Kansas rivers.

B. olmsteadi var. ozarcanum, Jordan. A "Johnny Darter." Neosho and branches.

B. mesotum, Cope. Clear sandy streams "in Kansas" Cope.

Genus Diplesion, Rafinesque.

D. blennioides (Raf.), Jordan. Green-sided Darter. A most beautiful fish. Wild Cat creek, near Manhattan; probably occurs throughout the State. (*Etheostoma blennioides* Raf. Journ. de Phys., 1819. *Hyostomo cymatogrammum* Jordan, Man. Vert.)

Genus Hadropterus, Agassiz.

H. phoxocephalus (Nelson), Cope and Jordan. Common in Marais des Cygnes. (*Etheostoma phoxocephalum* Nelson, Bull. Ills. Mus. Nat. Hist. I, 1876. Jordan, Man. Vert. ed. 2.)

Genus Etheostoma, (Pœcilichthys of Synopsis.) Rafinesque.

E. varietum, Kirt. var. spectabile Ag. Soldier-fish, Rainbow Darter, Blue Darter. Kansas river. Common.

E. Whipplei, Girard. Arkansas river. Perhaps doubtful in Kansas.

E. fusiforme, Jordan; embraces *barratti*, *gracilis*, *fusiformis*, *butlerianus* and *palustris* of the Synopsis. Common in Marais des Cygnes.

E. zonale, Cope, var. arcansanum, Jordan and Gilbert. Neosho river.

Genus Stizostedion, Rafinesque.

S. vitreum (Mitch.), Jordan and Copeland. Wall-eyed Pike, Dory, Glass-eye, Yellow Pike, Blue Pike, Jack Salmon. Kansas and Neosho rivers; probably in all waters of State. Valuable. (*Perca vitrea* Mitchell, Supl. Amer. Month. Mag., 1818. *Lucioperca americana*, Günther; Jordan, Bull. U. S. Nat. Mus. *Stizostethium vitreum* var. *Salmoneum* Jordan, Man. Vert.)

A. canadense (Smith), Jordan. Sauger, Sand Pike, Gray Pike, Horn-fish. Kansas river and Mill creek. (*Lucioperca canadensis*, C. H. Smith MSS. *Lucioperca grisea*, DeKay, N. Y. Fish Fauna, 1842; Jordan Bull. U. S. Nat. Mus.)

Genus Roccus, Mitchell.

R. chrysops (Raf.), Gill. White Bass, Striped Bass, "Grass Bass." "Eureka lake," (Kansas river.) (*Perca chrysops* Raf. Ich. Oh., 1820. *Labrax albidus*, DeKay, New York Fish Fauna, 1842.)

Family *Sciænidæ*.

Genus Aplodonatus, Rafinesque.

A. grunniens, Raf. Sheepshead, Thunder-pumper, Drum, Bubbler, Croaker, White Perch, Grunting Perch. Very common in Kansas river. (*Aplodinotus grunnieus* Raf., Jour. de Phys., 1819. *Amblodon neglectus* Girard, Mex. Bound. Surv., 1859.)

Family *Clupeidæ*.

Genus Clupea, Linnæus.

C. chrysochloris (Raf.), Jordan and Gilbert. Ohio Shad, Skip Jack. Abundant in larger streams. (*Pomolobus chrysoehloris* Raf., Ichth. Oh., 1820.)

TO BE LOOKED FOR.

Fishes probably occurring in Kansas waters, but not yet identified in the State:

1. Catostomus retropinnis, Jordan.
2. Moxostoma velatum, Cope.
3. Couesius physignathes, Cope
4. Zophendum plumbeum, Girard.
5. Notropis rubellus, Agassiz.
6. Aphredoderus sayanus, Gilliams.
7. Alvordius aspro, Cope.
8. Microperca punctutata, Putnam.
9. Roccus interruptus, Gill.

The following species have been taken from the Arkansas river or branches near Ft. Smith by Profs. Jordan and Gilbert, and probably occur in Kansas:

10. Ammocrypta vivax.
11. Hybopsis æstivalis.
12. Lepidosteus tristœchus (Bloch and Schneider) J. and G.
14. Cottogaster copelandi.
15. Hadropterus aspro.
16. Notropis whipplei.
17. Notropis illecebrosus, Girard.
18. Notropis blennius.
19. Noturus nocturnus, Jordan and Gilbert sp. nov.
20. Gambusia patruelis.
21. Placopharynx Carinatus, Cope.
22. Opsopœodus emiliæ.
23. Ulocentra histrio, Jordan and Gilbert, sp. nov.
24. Boleosoma camurum (Vailantia.)

FISHES PLANTED IN THE WATERS OF KANSAS BY THE STATE FISH COMMISSION.

Esox lucius, Linn. Common pike.
Stizostedion vitreum, Mitchell. Jack salmon.
Micropterus Dolomieu, Henshall. Small-mouthed black bass.
Roccus interruptus, Gill. Striped or yellow bass.
Ictalurus furcatus, Cuv. & Val. The channel and silver catfish.
Pomoxys annularis, Raf. Crappie, Newlight, etc.
Perca americana, Schranck. Yellow or ringed perch.
Salmo fontinalis, Mitchell. Brook trout, speckled trout.
Salmo irideus, Gibbons. Rainbow trout, California brook trout.
Oncorhynchus tchawytcha, Walbaum. Columbia salmon, Quinnat salmon.
Salmo salar var. Sebago, Linn. Land-locked salmon.
Clupea sapidissima. Common shad.
Cyprinus Carpio. German carp.

LIST OF UNIONIDÆ, COLLECTED IN KANSAS RIVERS, WITH LOCALITIES.

BY E. A. POPENOE, STATE AGRICULTURAL COLLEGE.

The following named fresh-water mussels have been collected within the few years past by myself, or, at my request, by Mr. S. C. Mason, and are now represented by series more or less full, in my private collection.

I must acknowledge my indebtedness to Mr. S. C. Mason, of Wakefield, Kansas, for his generous aid in collection; and to Mr. R. E. Call, of Des Moines, Iowa, for his kindness in examining and determining specimens.

The distribution of the species, so far as shown by the series in my collection, is indicated in the following list, by the abbreviations of the names of the rivers where found.

LIST OF LOCALITIES.

B. Blue river, at Manhattan.
W. Wild-Cat creek, near Manhattan.
D. Deep creek, near Wabaunsee.
N. Neosho river, near Burlington.
F. Fall river, in Elk county.
V. Verdigris river, in Wilson county.
K. T. Kansas river, at Topeka.
K. M. Kansas river, at Manhattan.
Other localities as written.

UNIO *alatus*, Say. B., W.
anodontoides, Lea. V., N., F., D., W.
asperrimus, Lea. V., N., F., B.
ater, Lea. F., N., V.
coccineus, Lea. Typical. F.
coccineus, Lea.
Var. *gouldianus*, Lea. V. F.
cornutus, Bar. F.
cylindricus, Say. N.
donaciformis, Lea. B., N.
fragosus, Con. F.
elegans, Lea. N., B., F.

UNIO *ellipsis*, Lea. K. T.
ellipsis, Lea.
Var. *arbiculatus*, Hill. B.
gibbosus, Bar. N.
gracilis, Bar. B., N., W., F.
lævissimus, Lea. W., B., K.T., K.M. Soldier creek, Shawnee county.
ligamentinus, Lam. N., F.
luteolus, Lam. D., W.
metanevrus, Raf. N., F., V.
multiplicatus, Lea. N.
parvus, Bar. D. Pipe creek, Ottawa county.
phaseolus, Hild. F., N.
Popenoi, Call. F.
pustulosus, Lea. N., F., B.
rectus, Lam. F., B., N.
rubiginosus, Lea. N., F.
securis, Lea. N.
solidus, Lea. N., V.
subrostratus, Say. D., W.
Topekaënsis, Lea. Dry Creek, Ottawa county.
tuberculatus, Bar. N., V. F.
undulatus, Bar. F., W., N., D., V.
ventricosus, Bar. F., N., B.
MARGARITANA *complanata*, Lea. W., N., D., F., V.
rugosa, Lea. N.
ANODONTA *Arkansensis*, Lea. W., F., V.
Danielsii, Lea. W.
grandis, Say. W., B., D.

MANHATTAN, KANSAS, Nov. 23, 1884.

A PARTIAL LIST OF THE KANSAS PARASIFIC FUNGI, TOGETHER WITH THEIR HOST-PLANTS.

BY W. A. KELLERMAN, PH. D., PROFESSOR IN THE KANSAS STATE AGRICULTURAL COLLEGE.

The fungi named in the following list were collected by myself during the present (1884), and the latter part of the previous season (1883), at which time I first came to the State. Of the new species, (described by J. B. Ellis and myself,) Septoria xanthifolia, E. & K., S. Cacaliæ, E. & K., S. gaurina, E. & K., S. Helianthi, E. & K., and Cercospora Vernoniæ, E. & K., were published in the American Naturalist, Nov., 1883; Æcidium Æsculi, E. & K., Æ. verbenicola, E. & K., Æ. Ceanothi, E. & K., Phyllosticta Cornuti, E. & K., P. verbascicola, E. & K., Septoria Cephalanthi, E. & K., S. Stenosiphonis, E. & K., Cercospora isanthi, E. & K., C. tuberosa, E. & K., C. oculata, E. & K., and C. Teucrii, E. & K., were published in the Bulletin of the Torrey Botanical Club, Oct., 1884; into the hands of the editor of the latter periodical has been placed for publication the manuscript, containing descriptions of the following: Cercosparella Apocyni, E. & K., Cercospora Cephalanthi, E. & K., C. chionea, E. & K., C. Desmodii, E. & K., C. Pentstemonis, E. & K., C. Gymnoeladi, E. & K., C. velutina, E. & K., Sphærella cercidicola, E. & K., S. Lactucæ, E. & K., and S. decidua, E. & K. Descriptions of the remaining new species, namely: Cercospora condensata, E. & K., C. condensata, var. Des-

manthus, E. & K., C. Fraxini, E. & K., C. Avicennæ, E. & K., C. Diantheræ, E. & K., C. glandulosa, E. & K., Ramularia Euonymi, E. & K., Gloeosporium fusarioides, E. & K., Phyllosticta Amaranthi, E. & K., Peronospora Oxybophi, E. & K., and P. Lithospermi, E. & K., also Cercospora granuliformis, E & Hol., and Gymnosporium harknessioides, E. & Hol., will be published in the Journal of Mycology, Jan., 1885.

Fourteen of the species (Nos. 3, 21, 24, 26, 54, 56, 66, 80, 94, 101, 103, 110, and 175) were collected in the Arkansas valley, in the southwestern portion of the State. All the others were obtained in the vicinity of Manhattan, in Riley county.

The arrangement of the genera in the different groups is substantially that in Cooke's Hand-book. For convenience of reference I arrange the species alphabetically under each genus.

It is with great pleasure that I take this opportunity to express my obligation to Mr. J. B. Ellis, who kindly assisted me in the determination of the species.

I.—List of Fungi.

USTILAGINEÆ.

1. Ustilago segetum, (Bull.,) (Uredo Carbo, DC.) On wheat and oats.
2. Ustilago Zeæ-Mays, (DC.,) U. Maydis, Lév.) On Zea Mays, L.
3. Entyloma Compositarum, Farlow.(?) On Gaillardia pulchella, Foug.
4. Entyloma Menispermi, Farlow & Trelease. On Menispermum Canadense, L.
5. Entyloma Physalides, (K. & C.) Winter (E. Besseyi, Farlow.) On Physalis sp.
6. Doassansia Alismatis, (Fr.) Cornu. On Sagittaria variabilis, Englm.

UREDINEÆ.

7. Uromyces Asclepiadis, Cke. (U. Howei, Pk.) On Asclepias Cornuti, Dec.
8. Uromyces Caladii, (Schw.,) U. Arisæmæ, Cke., (Uredo Caladii, Schw.) On Arisæma Dracontium, Schott.
9. Uromyces Euphorbiæ, C. & P. On Euphorbia dentata, Mx., E. heterophylla, L. E. maculata, L., E. marginata, Ph., E. petaloidea, Englm.
10. Uromyces Hedysari-paniculata, Schw., (U. Desmodii, Thüm., U. Desmodii, Cke.) On Desmodium sp.
11. Uromyces Lespedezæ, (Schw.) (U. macrosporus, B. &. C.) On Lespedeza capitata, Mx.
12. Uromyces Phaseoli, (Pres.), (U. appendiculatus, Lev.) On Phaseolus diversifolius, Pers., P. pauciflorus, Benth.
13. Uromyces Zygadeni, Pk. On Zygadenus Nuttallii, Nutt.
14. Trichobasis Crotonis, Cke. On Croton monanthogynus, Mx.
15. Puccinia Amorphæ, Curtis. On Amorpha canescens, Nutt.
16. Puccinia amphibii, Fuckl. On Polygonum amphibium, L.
17. Puccinia Artemisiarum, Duby. On Artemisia Ludoviciana, Nutt.
18. Puccinia Convolvuli, Cast. On Calystegia sepium, L.
19. Puccinia flosculosorum, (A. & S.,) (P. Compositarum, Schl.) On Vernonia Baldwinii.
20. Puccinia graminis, Pers. On various species of Gramineæ.
21. Puccinia Grindeliæ, Peck. On Grindelia squarrosa, Dun., var. grandiflora, Gr.
22. Puccinia Helianthi, Schw. On several species of Helianthus.
24. Puccinia Lithospermi, E. & K. On Lithospermum sp. (?)
25. Puccinia Maydis, Carrad., (P. Sorghi, Schw.) On Zea Mays.
26. Puccinia Malvacearum, Mont. On Malvastrum coccineum, Gray.
27. Puccinia Menthæ, Pers. On Mentha Canadensis, L., Monarda fistulosa, L.
28. Puccinia nigrescens, Peck. On Salvia lanceolata, Willd.
29. Puccinia Pruni-spinosa, (P.,) (P. Prunorum, Lk.) On Prunus Americana, Marshall.

30. Puccinia Saniculæ, Grev. On Sanicula Canadensis, L.
31. Puccinia Silphii, Schw. On Silphium integrifolium, Mx.
32. Puccinia Smilacis, Schw. On Smilax hispida, Muhl.
33. Puccinia Violæ (Schum.) On Viola cucullata, Ait., V. delphinifolia, Nutt.
34. Puccinia Xanthii, Schw. On Xanthium strumarium, L.
35. Phragmidium subcorticium (Schrank.), (P. mucronatum, Lk.) On Rosa lucida, Ehrh.
36. Gymnosporangium macropus, Lk. On Juniperus Virginiana, L.
37. Melampsora populina (Jacq.) On Populus monilifera, Ait.
38. Melampsora Salicis-caprææ (Pers.), M. salicina, Lév. On Salix longifolia, Muhl., S. nigra, Marsh.
39. Coleosporium Sonchi-arvensis (Pers.), (C. Compositarum, Lév.) On Vernonia Baldwinii, Torr.
40. Caeoma nitens, Schw., (C. luminatum, Schw.) On Rubus villosus, Ait.
41. Æcidium Æsculi, E. & K. On Æsculus glabra, Willd.
42. Æcidium asteratum, Schw. On Aster sp.
43. Æcidium Ceanothi, E. & K. On Ceanothus ovalis, Bigelow.
44. Æcidium Compositarum, Mort. On Erigeron annuum, Pers.
45. Æcidium Dicentræ, Trelease (?) On Corydalis aurea, Willd., var. occidentalis, Englm.
46. Æcidium Grossulariæ, DC. On Ribes rotundifolium, Mx.
47. Æcidium impatientatum, Schw. On Impatiens.
48. Æcidium Jamesianum, Pk. On Acerates viridiflora, Ell., Aselepias tuberosa, L.
49. Æcidium porosum, Pk. On Vicia Americana, Muhl. var. linearis.
50. Æcidium Smilacis, Schw. On Smilax hispida, Muhl.
51. Æcidium verbenicola, E. & K. On Verbena bracteosa, Mx., V. hastata, L., V. stricta, Vent.
52. Æcidium Xanthoxyli, Pk. On Xanthoxylum Americanum, Mill.

ENTOMOPHTHOREÆ.

53. Entomophthora Muscæ, (Cohn), (Empusa Muscæ, Cohn.) On house flies.

SPHAEROPSIDIÆ.

54. Conothyrium herbarum, C. & E. On Yucca angustifolia, Ph.
55. Phoma ustulatum, B. & C. (?) On Vitis cordifolia, Mx.
56. Darluca filum, Cart. On Puccinia sp.
57. Vermicularia albomaculata, Schn. (?) On Asimina triloba, Duu., Gymnocladus Canadensis, Lam.
58. Vermicularia dematium, Fr. On Ambrosia trifida, L., (old stems.)
59. Discosia maculicola, Ger. On apple leaves.
60. Discosia rugulosa, B. & C. On Carya sp.
61. Septoria Cacaliæ, E. & K. On Cacalia atriplicifolia, L., C. tuberosa, Nutt.
62. Septoria Campanulæ, Math. (?) On Campanula Americana, L.
63. Septoria Cephalanthi, E. & K. On Cephalanthus occidentalis, L.
64. Septoria gaurina, E. & K. On Gaura parviflora, Dougl.
65. Septoria Helianthi, E. & K. On Helianthus lenticularis, Dougl.
66. Septoria Inulæ, Sacc. & Spegz. On Helianthus mollis, Lam.
67. Septoria Kellermaniana, Thümen, n. s. (sporis bacillaribus, rectis, tenuissimus, simplicibus, vel vix visible septatis, 60–80x1.5mmm). On Vitis cordifolia, Mx.
68. Septoria psilostega, E. & M. On Galium sp.
69. Septoria Œnotheræ, West. On Œnothera biennis, L., Œ. serrulata, Natt.
70. Septoria Pruni, Ell. On Prunus Americana, Marshall.
71. Septoria Rhoidis, B. & E. On Rhus glabra, L.

72. Septoria Ribis, Desm. On Ribes rotundifolium, Mx.
73. Septoria Rubi, (Duby.) On Rubus villosus, Ait.
74. Septoria Sii, Desm. On Cicuta maculata, L.
75. Septoria Silenes, E. & M. On Silene noctiflora, L.
76. Septoria Stenosiphonis, E. & K. On Stenosiphon virgatus, Spach.
77. Septoria Speculariæ, B. & C. On Specularia perfoliata, A. DC.
78. Septoria Verbenæ, Rob. & Desm. On various species of Verbena.
79. Septoria xanthifoliæ, E. & K. On Iva ciliata, Willd., I. xanthiifolia, Nutt.
80. Phyllosticta Amaranthi, E. & K. On Amarantus retroflexus, L.
81. Phyllosticta Ampelopsidis, E. & M. On Ampelopsis quinquefolia, Mx.
82. Phyllostica cornicola, Desm. On Cornus paniculata, L'Her.
83. Phyllosticta Cornuti, E. & K. On Asclepias Cornuti, Dec.
84. Phyllosticta cruenta, Fr. On Polygonatum giganteum, Dietrich.
85. Phyllosticta Fraxini, E. &. M. On Fraxinus viridis, Mx.
86. Phyllosticta Labruscæ, Thüm. On Vitis cordifolia, Mx.
87. Phyllosticta phaseolina, Sacc. On Phaseolus diversifolius, Pers.
88. Phyllosticta platanicola, E. & K. On Platanus occidentalis, L.
89. Phyllosticta serotina, Cke. On Prunus serotina, Ehrh.
90. Phyllosticta smilacina, E. &. M. On Smilax hispida, Muhl.
91. Phyllosticta ulmicola, Sacc. On Ulmus fulva, Mx.
92. Phyllosticta verbascicola, E. & K. On Verbascum Thapsus, L.
93. Chætomella perforata, E. & E. On Cuicus altissima.

MELANCONEÆ.

94. Gloeosporium fusarioides, E. &. K. On Asclepias Cornuti, Dec.

TORULACEÆ.

95. Gymnosporium (?) harknessioides, Ell. & Holway. On Rosa lucida, Ehrh.

STILBACEÆ.

96. Epicoccum sphærospermum, Berk., (E. neglectum, Desm.) On Zea Mays, L.

DEMATIEÆ.

97. Helminthosporium gracile, Wallr. On Iris sp. cult.
98. Cercosporella Apocyni, E. & K. On Apocynum.
99. Cercosporella Fraxini, E. & K. On Fraxinus viridis, Mx.
100. Cercospora Acalyphæ. Pk. On Acalypha Virginica, L.
101. Cercospora altheina, Sacc. (?) On Callirrhoe involucrata, Gray (?)
103. Cercospora Asclepiadis, Ellis. On Asclepias Jamesii, Torr.
105. Cercospora Cephalanthi, E. & K. On Cephalanthus occidentalis, L.
106. Cercospora cercidicola, Ellis. On Cercis Canadensis, L.
107. Cercospora Chenopodii, Fres. On Chenopodium hybridum, L.
108. Cercospora chionea, E. & K. On Cercis Canadensis, L.
109. Cercospora condensata, E. & K. On Gleditschia triacanthos, L.
110. Cercospora condensata, var. Desmanthi, E. & K. On Desmanthus brachylobus, Benth.
111. Cercospora consociata, Winter (?). On Ruellia ciliosa, Ph.
112. Cercospora Desmodii, E. & K. On Desmodium acuminatum, Dce.
113. Cercospora effusa, (B. & C.,) (Cladosporium effusa, B. & C.) On Lobelia cardinalis, L.
114. Cercospora flagellaris, E. & M. On Phytolacca decandra, L.
115. Cercospora Diantheræ, E. & K. On Dianthera Americana, L. (Topeka, Popenoe.)
115a. Cercospora glandulosa, E. & K. On Ailantus glandulosa, Desf.
116. Cercospora granuliformis, Ell. & Holway. On Viola cucullata, Ait.
117. Cercospora Gymnocladi, E. & K. On Gymnocladus Canadensis, Lam.

118. Cercospora Isanthi, E. & K. On Isanthus cæruleus, Mx.

119. Cercospora moricola, Cke. On Morus rubra, L.

120. Cercospora murina, E. & K. On Viola cucullata, Ait.

121. Cercospora oculata, E. & K. On Vernonia Baldwinii, Torr.

122. Cercospora Pentstemonis, E. & K. On Pentstemon cobæa, Nutt., P. grandiflorus, Fraser.

123. Cercospora Physalidis, Ellis. On Physalis lanceolata, Lam., var. lævigata, Gr.

124. Cercospora Plantaginis, Sacc. On Plantago major, L.

125. Cercospera pustula, Cke., (C. ampelopsidis, Pk.) On Ampelopsis quinquefolia, Mx.

126. Cercospora racemosa, E. & K. On Teucrium Canadense, L.

127. Cercospora rhuina, C. & E. On Rhus glabra, L.

128. Cercospora Teucrii, E. & K. On Teucrium Canadense, L.

129. Cercospora tuberosa, E. & K., (C. glaucescens, Winter.) On Apios tuberosa, Mœnch.

130. Cercospora velutina, E. & K. On Baptisia Australis, R. Br.

131. Cerspora Vernoniæ, E. & K. On Vernonia Baldwinii, Torr.

132. Cercospora Violæ, Sacc. On Viola sp. cult., V. cucullata, Ait.

133. Ramularia Armoraciæ, Fuckl. On Nasturtium Armoracia, Fr.

134. Ramularia Celastri, E. & M., (R. Celastri, Peck.) On Celastrus scandens, L.

135. Ramularia Euonymi, E. & K. On Euonymus atropurpureus, Jacq.

136. Ramularia Grindeliæ, E. & K. On Grindelia squarrosa, Dun., var. grandiflora, Gr.

137. Ramularia obovata, Fuckl., (Peronospora obliqua, Cke.) On Rumex crispus, L.

138. Ramularia rufo-macularis, Pk. On Polygonum amphibium, L.

139. Ramularia Tulasnei, Sacc., (R. Fragariæ Peck.) On Fragaria sp. cult.

140. Ramularia Virga-aureæ, Thüm. On Solidago sp.

141. Macrosporium Maydis, C. & E. On Zea Mays, L.

142. Macrosporium Solani, E. & M. On Datura stramonium, L.

143. Fusicladium fasciculatum, C. & E. On Euphorbia petaloidea, Englm., E. hypericifolia, L.

144. Gyroceras Celtis, Mont. On Celtis occidentalis, L.

145. Stigmella visianica, Sacc. (?) On Platanus occidentalis, L.

MUCEDINEÆ.

146. Cystopus Bliti, (Biv.,) Lév., (C. Amaranti, S.) On Amarantus retroflexus, L.

147. Cystopus candidus, (P.,) Lév. On Nasturtium Armoracia, Fr.

148. Cystopus cubicus, (Strauss,) Liv. On Ipomœa leptophylla, Torr.

149. Cystopus Portulacæ, (D. C.) On Portulaca oleracea, L.

150. Microstroma leucosporum, Niessell. On Juglans nigra, L.

151. Peronospora australis, Spegaz., (P. sicyicola, Trelease.) On Sicyos angulatus, L.

152. Peronospora Corydalis, De Bary. On Corydalis aurea, Willd., var. occidentalis, Englm.

153. Peronospora Halstedii, Farlow. On Helianthus doronicoides, Lam., Ambrosia trifida, L., Silphium integrifolium, Mx., Vernonia Baldwinii, Torr.

154. Peronospora Oxybaphi, E. & K. On Oxybaphus Nyctagineus, Sweet.

155. Peronospora parasitica, (Pers.) Tul. On Draba Caroliniana, Walt.

156. Peronospora sordida, Berk. On Scrophularia nodosa, L.

157. Peronospora viticola, B. & C. On Vitis sp. cult., V. cordifolia, Mx.

158. Oidium fructigenum, Pers. On decaying plums.

SPHÆRIACEÆ.

160. Fusidium Ravenelianum, Thüm., (Ramularia Desmodii, Ck. On Desmodium sp.

ASCOMYCETES.

161. Exoascus deformans, (Berk.), (Ascomyces deformans, Berk.) On Peach leaves.

162. Exoascus Pruni, Fuckl. On Prunus Americana, Marshall.

163. Uncinula macrospora, Pk. On Ulmus fulva, Mx.

164. Uncinala spiralis, B. & C. On Ampelopsis quinquefolia, Mx.

165. Microsphæra Euphorbiæ, B. & C. (?) On Euphorbia marginata, Ph.

166. Microsphæra Friesii, Lev. On Syringa vulgaris, L.

167. Podosphæra tridactyla, (Wallr.,) (P. Kunzei, Liv.) On cultivated cherry.

168. Phyllactinia suffulta, (Reb.,) (P. guttata, Reb.) On Celastrus scandens, L.

169. Erysiphe communis, Schl. On Amphicarpæa monoica, Nutt.

170. Erysiphe lamprocarpa, Lev. On Verbena and many other plants.

171. Claviceps purpurea, (Fr.,) Tul. On rye.

172. Phyllachora Lespedezæ, (Schr.,) (Dothidea Lespedezæ, Schr.) On Lespedeza capitata, Mx.

173. Ophiobolus acuminata, son., (Sphæria carduorum, Wallr.) On Cnicus altissimus, Willd.

174. Ophiobolus porphyrogonas, (Tode,) Sacc., (Sphæria rubella, Pers.) On old stems of Scutellaria.

175. Physalaspora Arthuriana, Sacc. On Iva xanthifolia, Nutt.

176. Plowrightia, (Schu.,) (Sphæria morbosa Schu.) On Prunus Americana, Marshall.

177. Sphæria ulmea, Schu. On Ulmus Americana, L.

178. Sphærella cercidicola, E. & K. On Cercis Canadensis.

179. Sphærella decidua, E. & K. On Scrophularia nodosa, L. Vernonia Baldwinii, Torr.

180. Sphærella Lactucæ, E. & K. On Lactuca Canadensis, L.

181. Sphærella maculæformis, Pers. On Celtis occidentalis, L., Platanus occidentalis, L.

159. Oidium leucoconinum, Desm. On Rosa lucida.

II.—List of Host-Plants.

(The reference after each name is to the serial number in the List of Fungi.)

Abutilon Avicennæ, 104.
Acalypha Virginica, 100.
Acerates viridiflora, 48.
Æsculus glabra, 41.
Ailanthus glandulosa, 115.
Amarantus retroflexus, 80, 146.
Ambrosia trifida, 58, 153.
Amorpha canescens, 15.
Ampelopsis quinquefolia, 81, 125, 164.
Amphicarpæa monoica, 169.
Apios tuberosa, 129.
Apocynum, 98.
Apple leaves, 59.
Arisæma Dracontium, 8.
Artemisia Ludoviciana, 17.
Asclepias Cornuti, 7, 83, 94.
Asclepias Jamesii, 103.
Asclepias tuberosa, 48.
Asimina triloba, 57.
Aster, 42.
Baptisia Australis, 130.
Cacalia atriplicifolia, 61.
Cacalia tuberosa, 61.
Callirrhoe involucrata, (?) 102.
Calystegia sepium, 18.
Campanula Americana, 62.
Carya, 60.
Ceanothus ovalis, 43.
Celastrus scandens, 134, 168.
Celtis occidentalis, 144, 181.
Cephalanthus occidentalis, 63, 105.
Cercis Canadensis, 106, 108, 178.
Chenopodium hybridum, 107.
Cherry, 167.
Cicuta maculata, 74.
Cnicus altissimus, 93, 173.
Cornus paniculata, 82.
Corydalis aurea, var. 45, 152.
Croton monanthogynus, 14.
Datura stramonium, 142.
Desmanthus brachylobus, 110.
Desmodium, 10, 160.

Desmodium acuminatium, 112.
Dianthera Americana, 115.
Draba Caroliniana, 155.
Erigeron annuum, 44.
Euonymus atropurpureus, 135.
Euphorbia dentata, 9.
Euphorbia heterophylla, 9.
Euphorbia hypericifolia, 143.
Euphorbia maculata, 9.
Euphorbia marginata, 165.
Euphorbia petaloidea, 9, 143.
Fragaria, 136.
Fraxinus viridus, 85, 99, 168.
Gaillardia pulchella, 3.
Galium, 68.
Gaura parviflora, 64.
Gleditschia triacanthos, 109.
Gramineæ, 20.
Grindelia squarrosa, 21, 136.
Gymnocladus Canadensis, 57, 117.
Helianthus, 22.
Helianthus doronicoides, 153.
Helianthus lenticularis, 65.
Helianthus mollis, 66.
House flies, 53.
Impatiens, 47.
Ipomœa leptophylla, 148.
Iris, 94.
Isanthus cærulea, 118.
Iva ciliata, 79.
Iva xanthiifolia, 79, 175.
Juglans nigra, 150.
Juniperus Virginiana, 36.
Lactuca Canadensis, 180.
Lespedeza capitata, 11, 172.
Lithospermum sp., (?) 24.
Lobelia cardinalis, 113.
Malvastrum coccineum, 26.
Menispermum Canadense, 4.
Mentha Canadensis, 27.
Monarda fistulosa, 27.
Morus rubra, 119.
Nasturtium Armoracia, 133, 147.
Oats, 1.
Œnothera biennis, 69.
Œnothera serrulata, 69.
Oxybaphus Nyctagneus, 154.
Peach leaves, 161.
Pentstemon cobæa, 122.
Pentstemon grandiflorus, 122.
Phaseolus diversifolius, 12, 87.
Phaseolus pauciflorus, 12.
Physalis, 5.
Physalis lanceolata, 123.
Phytolacca decandra, 114.
Plantago major, 124.
Platanus occidentalis, 88, 145, 181.
Plums, 158.
Polygonatum giganteum, 84.
Polygonum amphibium, 16, 138.
Populus monilifera, 37.
Portulaca oleracea, 149.
Prunus Americana, 29, 70, 160, 176.
Prunus serotina, 89.
Puccinia, 56.
Rhus glabra, 71, 127.
Ribes rotundifolium, 46, 72.
Rosa lucida, 35, 95, 159.
Rubus villosus, 40, 73.
Ruellia ciliosa, 111.
Rumex crispus, 137.
Rye, 171.
Sagittaria variabilis, 6.
Salix longifolia, 38.
Salix nigra, 38.
Salvia lanceolata, 28.
Sanicula Canadensis, 30.
Scrophularia nodosa, 156, 179.
Scutellaria, 174.
Sicyos angulatus, 151.
Silene noctiflora, 75.
Silphium integrifolium, 31, 153.
Smilax hispida, 32, 50, 90.
Solidago, 140.
Specularia perfoliata, 77.
Stenosiphon virgatus, 76.
Syringa vulgaris, 116.
Teucrium Canadense, 126, 128.
Ulmus Americana, 177.
Ulmus fulva, 91, 163.
Verbascum Thapsus, 92.
Verbena, 78, 170.
Verbena bracteosa, 51.
Verbena hastata, 51.
Verbena stricta, 51.
Vernonia Baldwinii, 19, 39, 121, 131, 153, 179
Vicia Americana, 49.
Viola, 132.
Viola cucullata, 33, 116, 120, 132.
Viola delphinifolia, 33.
Vitis cordifolia, 55, 67, 86, 157.
Vitis sp. cult., 157.

Wheat, 1.
Xanthium strumarium, 34.
Xanthoxylum Americanum, 52.
Yucca angustifolia, 54.
Zea Mays, 2, 23, 96, 141.
Zygadenus Nuttallii, 13.

III.— INDEX TO THE GENERA.

(The numbers refer in each case to the first species of that genus in the List of Fungi.)

Æcidium, 41.
Cæoma, 40.
Cercospora, 100.
Cercosporella, 98.
Chætomella, 93.
Claviceps, 171.
Coleosporium, 39.
Coniothyrium, 54.
Cystopus, 146.
Darluca, 56.
Discosia, 56.
Doassansia, 6.
Entomophthora, 53.
Entyloma, 3.
Erysiphe, 169.
Epicoccum, 96.
Fusicladium, 143.
Glœosporium, 94.
Gymnosporangium, 36.
Gymnosporium, 95.
Gyroceras, 144.
Helminthosporium, 97.
Macrosporium, 141.
Melampsora, 37.
Microsphæra, 165.
Microstroma, 150.
Ophiobolus, 173.
Peronospora, 151.
Phoma, 55.
Phragmidium, 35.
Phyllachora, 172.
Phyllactinia, 168.
Phyllosticta, 80.
Physalaspora, 175.
Plowrightia, 176.
Podosphæra, 167.
Puccinia, 15.
Ramularia, 133.
Septoria, 61.
Sphærella, 178.
Sphæria, 177.
Stigmella, 145.
Trichobasis, 14.
Uromyces, 7.
Ustilago, 1.
Vermicularia, 57.

The evening was occupied by Rev. J. D. Parker, U. S. A., in a popular lecture upon "Circular Storms."

PROCEEDINGS OF THE THIRD DAY.

WEDNESDAY, NOVEMBER 26, 1884.

The President, Dr. Brown, in the chair. The following papers were then read.

REPORT OF THE COMMISSION ON CHEMISTRY UPON THE YEAR'S PROGRESS.

I. Organic and Physiological Chemistry.—By Prof. E. H. S. Bailey, *State University.*

In organic chemistry the field is a broad one, and it is only necessary to call attention to a few of the many discoveries of the year. Among these we note that M. A. Pohl has discovered a new putrefaction alkaloid from decayed flesh, having the composition $C_5H_{11}N$. G. Johnson recommends picric acid as a test for albumen in urine. A coagulum is formed when it is present. Use the solid or a saturated solution. This test is said to be more delicate than HNO_3. In the presence of KHO the solution changes from a deep yellow to a red. It is advisable to use equal volumes in all cases. The latest authorities on boric acid and borax as food preservatives, claim its use to be rather questionable. Their tendency is to decrease the amount of bile and of albuminous matter secreted. Hydric peroxide is coming into use as a disinfectant. A 3 per cent. solution in water is now made on a commercial scale. Hydric peroxide is very useful as an oxidizing agent in the place of nitric acid or bromine. It is particularly useful in the quantitative determination of sulphides and sulphites. Steps toward the artificial production of sinapic acid have been made by Remsen and Cole: the process is not yet completed. V. Meyer has shown that benzine obtained from coal tar, and that from benzoic acid, have different properties. From coal tar benzine a compound called theophane, containing sulphur, can be made, while this cannot be made from the other variety. Ethyl orange is one of the very best test solutions to distinguish between an acid and an alkali. From an alkali to an acid the change of color is from orange to rose. Nicol has brought forward a new hypothesis in regard to solution. He assumes that the solution of a salt in water is in consequence of the attraction of the molecule of water for a molecule of the salt exceeding that of the molecules of the salt for each other. At saturation the attraction of dissimilar molecules is counterbalanced by that of similar molecules.

From elaborate investigations, Fleischer has ascertained that sulphuric acid is a much better drying substance to use in a desiccator than calcic chloride. Solomon has made an investigation on the action of acids on starch. Musculus thought that by diastase, as well as by sulphuric acid, starch split up into one molecule of dextrine and one of sugar, and afterwards the acid slowly acted on the dextrine. Payen opposed this view, and showed that no such breaking up of the molecule took place, but that there was a gradual change. Opinions have been divided on the question, but Solomon shows that the change by acids is more rapid as the acid is stronger; it is in proportion to the time of action, but slower towards the end. Oxalic acid changes starch readily to sugar in three hours. The starch group is composed of x molecules of $C_6H_{10}O_5$, and is changed by the action into a simpler soluble starch, and this latter to dextrine. This final change is rapid. Sulphuric acid unites with a certain quantity of the dextrine and hydrates it, to give it up again to unite with a new quantity of dextrine, and change the latter to

sugar. Recent patents have been taken out, by which an excellent quality of crystalized grape sugar can be made. The product is actually the hydrate, and does not absorb water readily. The chief modification from the ordinary method of manufacture is that the liquid grape sugar is absorbed by some porous substance. Experiments with a great variety of antiseptics, have shown that borax and boracic acid have the greatest power in this direction. The difference between new and stale bread is not on account of less water in the latter, but because a molecular change has taken place. The sticky or elastic condition of new bread is the only reason why it is less digestible than the stale. Recent French chemists claim to have discovered that alcohol is made in the system, even if sugar and other fermentable substances do not form part of the diet. Salicylic acid, if introduced into the system, is eliminated by the kidneys and liver. It usually does no harm, but as in certain conditions of the system, and in certain temperaments, it may do harm, its use as a food preservative cannot be recommended. Boiling oxygen has been used as a refrigerant. By its use, nitrogen may be obtained in snow-like flakes.

O'Shea has investigated bleaching powder, and finds the symbols to be Ca—O—O Cl. Water decomposes it into Ca ($O Cl_2$) and Ca Cl_2. The specific gravity of liquid oxygen at minus 130° Centigrade is .899. Brucine is proposed as a test for tin. A nitric acid solution is used; this is diluted with water, and heated to boiling. It gives a purple color with stannous compounds.

II. Agricultural and Analytical Chemistry.— By J. T. Willard, *State Agricultural College.*

In preparing this review of the Progress in Agricultural and Analytical Chemistry, the writer has been impressed by the mass of really valuable acquisitions of the past year. His only difficulty has been to select from this abundance that which is of the most importance and will most truly show the advances that have been made. This selection has doubtless been influenced somewhat by his personal appreciation of certain points, while another would have laid the greater stress upon other lines of work. Some very valuable papers from their length can only be referred to, while many of scarcely less value than those to be noticed presently cannot be alluded to at all.

A large portion of the work in agricultural chemistry has consisted of experiments to determine the effect of certain fertilizers on various crops. These experiments, while quite valuable, cannot be mentioned in detail. Prof. Paul Wagner has conducted a series of manuring experiments with such care that his results are almost as accordant as accurate chemical analyses. After five years' experience, he insists that a tolerably exact experiment in manuring requires the strict adherence to the methods which he describes. (*Journal Chem. Society, No. CCVLIII, p. 634.*)

Dr. A. B. Griffiths finds that in solutions containing an increased amount of ferrous sulphate up to .15 per cent. plants grow much better, especially those containing a large amount of chlorophyl; while in solutions containing .2 per cent., seeds will not germinate and plants die. (*Chem. News, vol. 50, p. 167.*) Other experiments of his tend to the conclusion that chlorophyl is a compound of iron with a glucoside. (*C. N., 49—237.*)

Dr. T. L. Phipson, about a year ago, published an article upon the production of oxygen by certain unicellular algæ. (*C. N., 48—205.*) He has since published the results of other experiments showing that plants have not the power to take carbon dioxide from water and decompose it liberating oxygen, if the water contains *only* carbon dioxide; something else is necessary, and this, he asserts, is hydrogen peroxide. He attributes the evolution of oxygen to reactions between CO_2 and $H_2 O_2$ by which ternary compounds are formed in the plant and oxygen liberated. (*C. N., 50—37.*)

G. Bonnier and L. Mangin. Comparative experiments respecting the oxygen absorbed and the carbon dioxide evolved in the dark by various species of plants, show that the ratio between the two quantities is constant, whatever the temperature, but that the ratio varies for different plants. The activity of the action increases rapidly with the temperature. (*J. C. S., CCLXI—857.*)

Pichard has made some interesting researches in nitrification. He finds that certain salts, if applied to the soil exercise an energetic nitrifying power. The effect was especially marked with calcium sulphate. Taking that as 100, the nitrifying power of sodium sulphate was 47.91; of potassium sulphate, 35.78; of calcium carbonate, 13.32; and of magnesium carbonate, 12.52. This remarkable power of gypsum explains its beneficial action when used as a fertilizer. Its application to soils poor in calcium compounds cannot be too highly recommended. (*J. C. S., CCLXII—924.*)

G. Marek has made analyses determining the distribution of the sugar in the beet. He divided the beet into eight sections from top to bottom, and determined the sugar in each. The rotatory power was greatest in the second section, and decreased downward. The upper section is between the fifth and sixth in amount of sugar. He also determined the lateral distribution of the sugar, and found the largest amount in a zone between one-seventh and two-sevenths of the distance from the outside to the center. (*J. C. S., CCLX—766.*)

Messrs. Lawes and Gilbert have published a long memoir on the composition of the ash of wheat straw and wheat grain, showing the influence of varying seasons and different manures. The length of the paper forbids any attempt at abstraction. (*J. C. S., CCLXI—305.*)

The most striking feature in the progress of analytical chemistry, is the number of methods which have been proposed for the detection or estimation of nitrogen in its various combinations. Accurate valuations of nitrogenous fertilizers are of growing importance to agriculture, and the attention of agricultural chemists throughout the world is directed toward this subject. At the instance of the German Manure Manufacturers' Association, a general meeting of chemists was held at Wiesbaden, last May, under the Presidency of Prof. Fresenius, to consider proposals for uniform methods for nitrogen determinations. They agreed upon methods for the preparation of samples, and the determination of ammoniacal, organic, and nitric nitrogen. (*C. N., 50—180.*)

A new method of estimating organic nitrogen has been devised by J. Kjeldahl. The dried substance is digested for several hours with concentrated sulphuric acid, at near the boiling point of the acid. The conversion of the nitrogen into ammonia is completed by adding potassium permanganate in very small quantities until an excess is indicated by the solution becoming green. When cold the solution is made alkaline by a strong solution of caustic soda and the ammonia is distilled into standard acid. The author has obtained satisfactory results with a large variety of nitrogenous substances. (*J. C. S., CCLVI—364.*)

Prof. S. W. Johnson finds that simply calcium hydrate may be substituted for soda-lime in the conversion of organic nitrogen into ammonia for purposes of analysis. (*Am. Chem. Journal, Vol. 6, p. 60.*)

G. Lunge.—(1) Lime, soda and magnesia in excess liberate all the ammonia in ammonium chloride equally well. (2) Amines are liberated under the same circumstances as ammonia, so that the assumption that magnesia avoids the decomposition of amines which may be present in commercial manures is quite erroneous. (*J. C. S., CCLX—776.*)

A. G. Green and S. Rideal have published a method of determining nitrous acid by means of a one-tenth normal solution of pure aniline, which they maintain is more accurate than the permanganate process, and can be used in the presence of oxidizable substances. (*C. N., 49—173.*)

M. Arnaud has developed a method of precipitating nitric acid as cinchonamine nitrate. It may be used for the estimation of nitric acid in natural waters and in plants. The method possesses several advantages, among which is the high molecular weight of the precipitate. Very good results have been obtained, but the details of the process cannot be given here. (*C. N., 50—103.*)

Several qualitative tests for nitric acid and nitrous acids have been proposed, but space forbids any further mention of them.

Considerable attention has also been given to the determination of carbon in iron and steel. Most of the progress, however, consists in modifications of the well-known methods. Zaboudsky decomposes the finely pulverized sample by means of a mixture of sodium chloride and cupric chloride, instead of cupric-ammonium chloride. The decomposition is completed in about forty-five minutes. His method contains other modifications of the ordinary process also. (*C. N., 50—57.*)

A. B. Clemence filters the carbon after its separation from iron directly into a platinum combustion tube. The tube is eleven and one-half inches long, three-fourths of an inch wide for seven inches, and then contracts rapidly to three-sixteenths of an inch. An asbestos filter is placed at the point where the contraction begins. (*C. N., 48—206.*)

R. W. Atkinson has made some valuable investigations on the standarizing of potassium bichromate. He also condemns the use of stannous chloride as a reducing agent in analyses of iron, on account of the difficulty with which the excess of the reagent is accurately destroyed. Since zinc chloride diminishes the delicacy of the ferri-cyanide reaction, he strongly recommends ammonium bisulphite for the reduction of ferric compounds when potassium bichromate is used in the titration. (*C. N., 49—217.*

G. Bruel uses sodium salicylate as an indicator in the titration of ferric solutions with sodium thiosulphate. (*J. C. S., CCLVI—367.*)

Thomas Moore describes a method of separating nickel and zinc, which seems to be much superior to the method with hydrogen sulphide and sodium acetate. (*C. N.*, 501—51.)

Mr. E. R. Dryer finds brucine a more convenient, more delicate and more striking test for tin than the mercuric chloride test. .1 gram brucine is dissolved in 1 c.c. strong nitric acid and diluted to 50 c.c. (*C. N., 48—257.*)

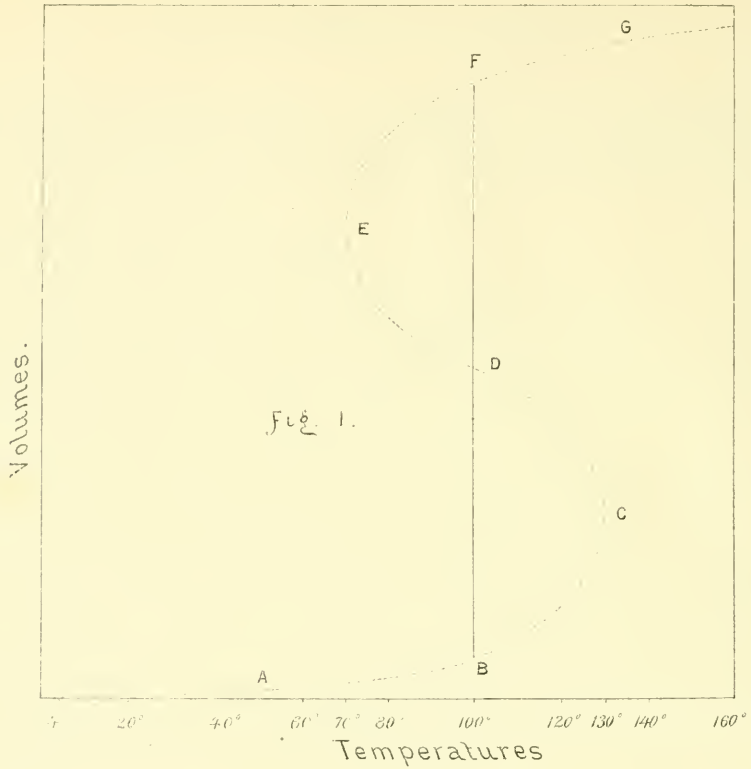
A new method of separating strontium and calcium has been devised by M. D. Sidersky. It is based on the fact that when a mixture of ammonium sulphate and ammonium oxalate is added to a solution containing strontium and calcium, the strontium is precipitated as sulphate while the calcium remains in solution and may be precipitated from the filtrate by supersaturating with ammonia. The reagent contains three per cent. of ammonium oxalate and twenty per cent. of ammonium sulphate. (*C. N., 48—296.*)

A. Cavazzi.—In a mixture of chlorides, bromides and iodides, the iodine may be determined by distilling the solution with ferric sulphate and collecting the iodine in potash. The ferric sulphate must be calcined to remove traces of acid, and a small amount of ferrous sulphate is added to increase the solubility of the ferric salt. *C. N., 49—14.*)

David Lindo has made an exhaustive examination of the oxalic acid method of separating phosphoric acid, for determination as magnesium pyro-phosphate. Space does not admit of useful abstraction. (*C. N., 48—217, 230 and 239; also 49—247.*)

Thomas S. Gladding, in a series of experiments on natural phosphates, artificial soils and natural soils, has demonstrated that soluble phosphates become reverted very rapidly in both natural and artificial soils, and that if iron or alumina is present the reverted phosphates are not entirely taken up by a neutral solution of ammonium citrate at 40° C., but are entirely dissolved by the same reagent at 65° C. (*Am. Chem. Jour., 6—1.*)

Prof. Lord recommends the use of ammonium fluoride, instead of a mixture of


G
F
E
D
C
A
B
Volumes.
Fig. 1.
20°
40°
60°
70°
80°
100°
120°
130°
140°
160°
Temperatures

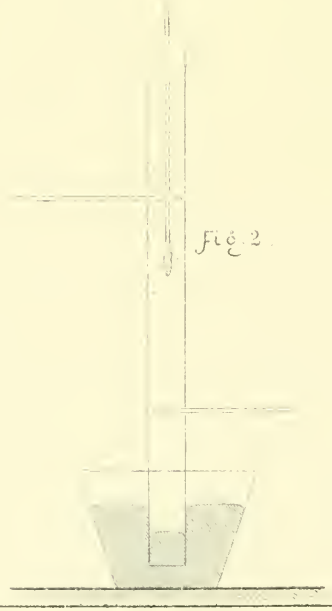


Fig. 2.

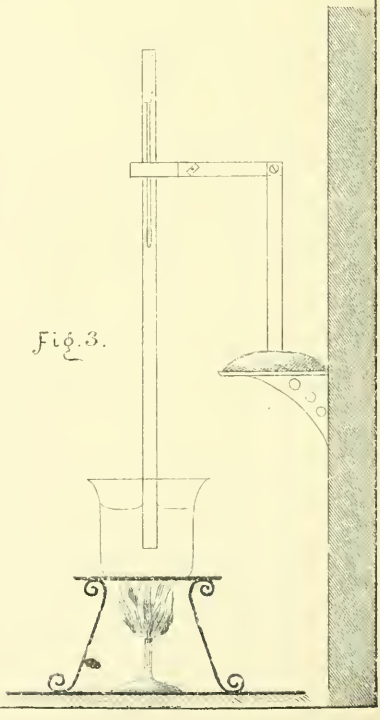


Fig. 3.

fluor-spar and potassium bisulphate, as a blow-pipe reagent in the detection of boron and the alkalies in their mineral combinations. (*C. N., 49—269.*)

According to E. Fischer, para-amido-dimethyl-aniline sulphate is a much more delicate test for hydrogen sulphide than either lead acetate or sodium nitro-prusside. (*J. C. S., CCIV—109.*)

For the detection of free sulphuric acid in vinegar, Wharton evaporates down to a syrup, lets cool to a hand-heat, and then stirs in a few centigrams of potassium chlorate. If there is more than one per cent. of sulphuric acid the mass ignites violently. Smaller quantities are detected by the odor of chlorine. (*C. N., 50—68.*)

R. T. Thompson has made a large number of observations on the use of litmus, rosolic acid, methyl-orange, phenacetolin, and phenolphthaleïn as indicators. The writer can only refer to the original articles. (*C. N., 49—32, 38 and 119.*)

EXPERIMENTS UPON SUPER-HEATED LIQUIDS AND UPON THE SUPER-SATURATION OF VAPORS.

EDWARD L. NICHOLS, PH. D.

I.

It is the purpose of this paper to describe some experiments upon the behavior of liquids heated beyond their boiling points under conditions which prevent ebullition, and of vapors cooled below the temperatures at which they ordinarily return to the liquid state.

Professor James Thomson*, in a discussion of Andrews's† well-known experiments on the continuity of the liquid and gaseous states, has shown that there are reasons for thinking that under proper conditions liquids might be converted into vapor even below the critical temperature without discontinuity; and he has shown the general form which the curve indicating the changes of volume might be expected to take. The change of state may be brought about by decrease of pressure or by increase of temperature. The former was the method adopted by Andrews in his research upon carbonic acid, and the curves given in Thomson's paper, based upon those experiments, are isothermal curves indicating variations of volume with the pressure. All that he has said on this subject is applicable, however, to methods in which the temperature is varied.

When heat is applied to a liquid at ordinary pressures, volume and temperature vary simultaneously until the boiling point is reached, when the temperature becomes constant and the familiar expansion-curve becomes a straight line, parallel to the axis along which volumes are measured. Figure 1 shows this curve (A B F G) in the case of water heated at a pressure of 760 mm. We know from the experiments of Donny‡, Dufour⁂ and others upon superheated liquids, that the curve does not always take this form, since water, holding no absorbed gases and contained in perfectly clean vessels, can be heated far above its boiling point without ebullition. The general form pointed out by Thomson for the isothermal method, but applied to the isobaric expansion-curve, is shown in the dotted line (B C D E F). The condition under which a liquid will follow the limb B C D is the absence of absorbed gases. The limb F E D should be obtained by cooling a vapor in the absence of its liquid.

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*James Thomson; Report of the British Association for the Advancement of Science, 1871; also Proceedings of the Royal Society, 1859 and 1871.

†Andrews; Philosophical Transactions, 1869.

‡Donny; Annales de Chimie, 1846, 3d series, Vol. XVI.

⁂Dufour; Bibliotheque Universelle, Archives 1861, Vol. XII.

The experiments to be described here consisted of attempts to fulfil these conditions, and thus to compel the substance in changing state to follow the continuous instead of the broken curve.

II.

By the simple method described to the Academy of Science at its last meeting,* I have found it easy to prevent water in newly-blown bulbs from boiling until 130° was reached, at which temperature, as in Donny's experiment, it invariably boiled explosively. Sulphuric ether and bisulphide of carbon in such bulbs frequently attained a temperature of 80° or 90° before boiling, and then burst explosively into gaseous form. Above the normal boiling point, the expansion of the liquid was very rapid, but I have not as yet succeeded in measuring it. The liquid in these experiments was separated from the outer air by a short column of mercury, and when the change of state occurred, this mercury was driven forcibly from the tube, together with the entire contents of the bulb.

Upon placing a bulb filled with ether in a paraffine bath at 200°, the bead of mercury being omitted, I found to my surprise that the ether, as in former trials, refused to boil, and that although exposed to a temperature vastly above its boiling point, it remained perfectly quiescent, going over into the gaseous state without ebullition. That the liquid was superheated, was shown by its rapid expansion, but this expansion was followed by a diminution of volume, which continued until the liquid had all disappeared. Inspection showed that the ether, during this process of contraction, *was in the spheroidal state.* From previous well-known experiments upon the spheroidal state, we know that the temperature of the liquid is always considerably below the boiling point. In this case the transfer from the liquid to the gaseous state occurred under conditions such that the expansion-curve was a continuous one. The general form was evidently that predicted by Thomson—in the paper already cited—the temperature and volume increasing to the point C (fig. 1), several degrees above the boiling point, when the liquid, without boiling, assumed spheroidal form, and the temperature fell to a minimum at E, considerably below the boiling point.

The experiment as above described was repeated many times, and always with the same result. It succeeded equally well where bisulphide of carbon was used instead of ether, and would probably succeed in case of water in a bath of temperature sufficient to throw that liquid into spheroidal form. Several attempts to repeat this experiment with a thermometer immersed in the liquid failed. Nuclei of occluded gases, upon the bulb of the thermometer, which no amount of cleansing with acids or caustic alkali entirely removed, invariably induced boiling of the liquid as soon as it was placed in the paraffine bath. Probably the only method by which the temperature of the liquid during the entire experiment could be determined, would be by the use of a newly blown and consequently perfectly clean thermometer. I hope, by means of an air thermometer of proper form, to succeed in measuring these temperatures and also the accompanying changes of volume.

The conditions under which liquids may be converted into vapor without presenting the usual broken expansion-curve may be briefly stated as follows:

1. The liquid must be free from absorbed gases, and it must be heated in a vessel upon the inner surface of which no gases are occluded.

2. It must be subjected to a temperature sufficient to produce the spheroidal state without ebullition.

3. It must have a free surface in contact with the air.

* A Class-room Experiment on Superheated Liquids: Proceedings of the Kansas Academy of Science, 1883. [This method consists of removing the air from water by repeated boiling in a small and newly-blown bulb with a narrow neck, after which it is separated from the atmosphere by a bead of mercury. Upon heating again, ebullition is invariably delayed until, at about 130°, the entire contents of the bulb is expelled by explosive boiling.]

III.

Upon the super-saturation of vapors there exist, so far as I know, no published researches; and aside from Professor Thomson's paper (already cited) and a brief allusion to that paper in Maxwell's* *Theory of Heat*, the subject has attracted but little attention. My attempts to realize the conditions under which vapors might be cooled below the boiling point without condensation were begun in 1880. Believing the immediate cause of condensation to be the presence of nuclei of the substance in question in liquid form,† I collected steam in inverted glass tubes filled with heated oil; the mouths of the tubes dipped into an oil bath, and in some cases the whole tube was submerged. The steam, however, condensed upon the sides of these tubes, in the form of dew, whenever the bath was allowed to cool to the boiling point of water. The film of oil upon the glass was doubtless insufficient to prevent the steam from coming in contact with the hygroscopic surface of the glass.

Some experiments made in 1882 were more successful. A glass tube (fig. 2) 5 cm. in diameter and 50 cm. long, open at both ends and having two tubulatures through which thermometers were inserted, was placed with its lower end in a bath of mercury and filled with linseed oil. The mercury was heated to 150° and a few drops of water were introduced into the column of oil. Upon reaching the hot mercury at the bottom of the tube the water boiled, and bubbles of steam rose through the oil without condensing until a point was reached which had a temperature of 70°, when it condensed suddenly. During the course of the experiment, the oil being gradually heated from below, this 70° level rose and the point of condensation rose with it until the entire column of oil was hotter than 70°, when the steam condensed at the surface. Upon substituting bi-sulphide of carbon for the water in this experiment, and water for the oil, a similar result was reached. The bi-sulphide of carbon vapor rose uncondensed through water whenever the latter was above 35°, a temperature 10° below the boiling point of the substance. Steam generated outside the apparatus and introduced into the column of oil from below behaved in the same manner as that produced by boiling drops of water in the tube itself. When led, for comparison, into warm water, it condensed explosively, in the usual manner, until the water itself had begun to boil.

To determine whether other liquids than oil would serve as an envelope for the isolation and consequent super-saturation of steam, I introduced dry steam into moderately warm dry mercury. The behavior of the vapor within the mercury could of course not be directly observed, but the surface of the latter became coated with minute globules of water in the form of dew, indicating, I think, that it had risen through the mercury in the form of vapor and condensed at the surface. Whenever condensation below the surface occurred, as in the cases in which wet steam was used, no dew appeared and the water collected in considerable quantities before rising to the surface of the mercury.

I have recently repeated these experiments in a slightly modified form. A glass tube (fig. 3) rather more than a metre in length, two centimetres wide, and closed at the lower end, was filled with oil, and immersed to a depth of four or five centimetres in an oil bath at 200°. Such a column of oil heats slowly, and the temperature decreases

* Clerk Maxwell, Theory of Heat, p. 124.

† The view of the processes of ebullition and condensation upon which this opinion is based has been more clearly stated in Maxwell's treatise (just referred to) than in any work with which I am acquainted. According to this view they are special cases of the general process known as fluid diffusion. Ebullition consists of an inrush of liquid particles into gaseous nuclei contained within the body of the liquid or occluded upon the walls of the vessel. The absence of such nuclei precludes boiling and permits of super-heating. Condensation is the reverse process in which particles of a vapor enter liquid nuclei, becoming part of them and producing drops of the liquid. The absence of such nuclei might be expected from the nature of the case to prevent condensation and make super-saturation possible.

regularly and gradually from the bottom upward. Water introduced into the tube boiled upon reaching the bottom, and the vapor rose slowly until it reached a level possessing a temperature between 60° and 70°, when it condensed. The experiment was repeated many times, under varying conditions, and with different kinds of oil, but always with the same result.

IV.

In these experiments it was unfortunately impossible to measure the temperature of the vapor itself. It seems highly improbable that bubbles of steam rising slowly through a meter or more of oil would maintain a temperature thirty degrees above that of the surrounding liquid; and the following considerations, the result of repeated observation, are thought sufficient to show that the difference between the temperature of the vapor and the oil through which it passed was very small:

1. The bubbles of vapor contracted continually up to the moment of condensation, and as nearly as could be estimated the contraction was such as would have resulted had the bubbles assumed the temperature of the liquid through which they were passing.

2. The upward velocity of the bubbles varied greatly with the viscosity of the oil, being about 120 cm. per second in castor oil, and 200 cm. per second in linseed oil; but the apparent temperature of condensation, while it varied somewhat in different oils, being about 62° in castor oil, 67° in olive oil, and 70° in linseed oil, was lowest in the most viscous and highest in the most limpid of these oils. If there had been a great difference of temperature between the vapor and the oil, the *apparent* temperature of condensation would have been higher in the more viscous oils than in those through which the bubbles of steam rose more rapidly. That is to say, the temperature of the vapor at the time of condensation would be more nearly that of the surrounding oil in the case of viscous oils, because of the longer time for cooling.

3. The apparent temperature of condensation was not the same throughout the course of an experiment. It was somewhat lower at first when the vapor condensed near the bottom of the tube than when it passed to the top of the tube before liquefying. This would seem to indicate that the vapor did not instantly assume the temperature of the oil through which it was rising; but the apparent temperature of condensation did not vary more than four or five degrees between the bottom and top of a column (a metre long) of the most viscous of these oils.

4. Large and small bubbles had the same apparent temperature of condensation.

5. Steam confined within glass tubes, (below the surface of an oil bath,) as in the first experiment described in this paper, condensed as soon as the *bath* reached the boiling point of water. In this case the *apparent* temperature of condensation was also the *true* one, and I believe it may be so considered in all these experiments without serious error.

The temperature of condensation of super-saturated steam obtained by this method is as far below the boiling point as the temperature of explosive ebullition in Donny's experiments and those described in a previous paragraph lie above that point; *i. e.*, about 30°. The temperature 70° and 130° are then those of the maximum (C) and minimum (E) of the continuous expansion-curve. The portions B C and E F are plainly determinable. Under conditions which permit ebullition after super-heating, the portion C D E, as has been pointed out by Maxwell*, cannot be determined; but the experiment with ether in which the liquid did not boil at all, indicates conditions under which the curve is of a determinate character throughout.

As the boiling point approaches the critical temperature, the maximum and minimum become less marked, and finally disappear. Whether the curve at a given pressure varies also with the conditions of the experiment, as Dufour's experiment, in which

*Clerk Maxwell, Theory of Heat, p. 127.

water enveloped in oil boiled at 180°, and the different temperatures at which steam condensed in different oils (in my experiments) would seem to indicate, must be determined by further and more exhaustive research.

UNIVERSITY OF KANSAS, November 26, 1884.

STATISTICS ON COLOR-BLINDNESS IN THE UNIVERSITY OF KANSAS.

EDWARD L. NICHOLS, PH. D.

[Abstract.]

During the past two years I have tested the members of my classes in physics for color-blindness with the Holmgren worsteds. The primary object in these tests was the practical illustration of this interesting subject in the class-room, but the statistics thus collected have some features which may be of more general interest.

The most noteworthy of these is the unusual prevalence of "incomplete" green-blindness among our students. From the far more extended series of tests already made in Europe,* and elsewhere in this country,† it has been ascertained: that among men about 4 per cent. are completely color-blind; that "red" and "green" blindness are about equally prevalent; and that with very few exceptions women are not color-blind.

The results of my tests were in accordance with those made elsewhere, so far as the above-mentioned particulars are concerned. Of 137 young men subjected to the Holmgren test, five were found to be completely red-blind and four completely green-blind. Of 93 young women, one was completely red-blind. The percentage of those completely color-blind, (6.56 per cent for males,) while above the average, is not in excess of the percentages frequently obtained by other experimenters. (Dr. Feris, for instance, found in testing 501 French sailors that 8.18 per cent. of them were color-blind. Dr. Dor, who tested 611 women in Breslau, found 0.82 per cent. of them to be color-blind.) The number of cases in which the perception of green was notably deficient — in other words, the amount of incomplete green-blindness — was, however, surprisingly large. Besides the four persons classed as completely green-blind, no less than eighteen were found to be incompletely green-blind; so that, including the former, more than 16 per cent. of all the males tested were pronouncedly green-blind. Of the usually more prevalent type, (red-blindness,) but four cases were detected. The total amount of red-blindness was therefore less than 6 per cent. Among the female students, on the other hand, but two cases of green-blindness were found, and in both the deficiency was very slight; while four cases of incomplete red-blindness were recorded.

Even this great excess of green-blindness over the other common variety is not unprecedented. Dr. Krohn, who tested 1,200 railroad employés in Finland, found the ratio of green-blindness to red-blindness to be even larger — *i. e.*, 25: 4. More commonly, however, the latter is the prevailing type; to the extent in Favre's tests upon French railways, for instance, of 13: 1.

The great differences exhibited in color-blind tests, in different parts of the world, are doubtless to a considerable extent due to the different methods pursued, and in the earlier investigations, to the very imperfect knowledge of the subject possessed by those

* For an account of the principal European investigations prior to 1877, see F. Holmgren; *De la Cécité des Couleurs dans ses rapports avec les Chemins-de-fer et la Marine*, Stockholm, 1877. (Translated in Smithsonian Reports for 1877.)

† See B. Joy Jefferies' work (Color-blindness and its Detection, Boston).

who first began to gather statistics upon it.* They probably depend also upon differences in the color sense of the classes of individuals tested, which if properly followed up, would lead to much needed knowledge of the causes of color-blindness, and of the laws which govern it. In some recent experiments upon a closely-allied topic—the sensitiveness of the eye to colors of a low degree of saturation †—I discovered among fifty-four of the young men and women, who kindly aided me in that investigation, and who were also included in the color-blind tests, the following almost universal peculiarity of color-perception, which is probably closely related to this prevalence of green-blindness. This peculiarity consists of a marked lack of sensitiveness to the presence of *green* when mixed with large quantities of white. It was found, for instance, that on the average, these observers could detect the presence of 25.2 parts of red lead when mixed with 100,000,000 parts of white, 23.9 parts of chrome yellow, and 125.5 parts of ultra marine, under the same circumstances; whereas 864.3 parts of chrome green in 100,000,000 were necessary to the detection of the pigment.

In describing those experiments, I ventured the suggestion that the difference is due to a blunting of the nerves, the function of which it is to carry the perception of green to the brain, by continual exposure to the hues of foliage, etc. That temporary incomplete color-blindness may be induced at will by wearing spectacles of a tint that overtaxes certain sets of nerves, is well known. May not life-long exposure to the prevailing green of the landscape, generation after generation, well be supposed to produce permanent incomplete green-blindness?

THE WATER OF THE FORT SCOTT ARTESIAN WELL.

BY E. H. S. BAILEY AND E. W. WALTER.

Several months ago our attention was called to the new artesian well which had been bored at Fort Scott, in this State. Through the kindness of Mr. E. F. Ware, the secretary of the Artesian Well Company, we received samples of the water, with details of the conformation of the strata through which the boring passed. The original idea was to sink a gas well; little gas however has been noticed, but a flowing artesian well has been the result of the enterprise. A water of a slighty sulphurous odor rises smoothly and steadily in the six-inch tube.

In regard to the position of the well, its mouth is 840 feet above the level of the sea, this computation being based on the surveys of the Gulf Railroad Company. The well is bored upon the first bench on the south side of the Marmaton river, at the foot of the bluff, and 550 feet from the channel. The mouth of the well is 100 feet lower than the plateau. Above the mouth of the well is the bluff, consisting of limestone, hydraulic cement rock, coal, fire clay, and bituminous shale.

The diameter of the well is eight inches down to 335 feet, to which point the well was tubed with iron pipe to shut off the surface-water. Below that point the well was bored dry 45 feet to a depth of 380 feet, at which point the drill struck a 14-inch crevice and salt water rose to within 10 feet of the surface.

The boring was continued to a depth of 610 feet, when a different kind of water was reached, which began to flow slowly from the well. At a depth of 621 feet, the boring

*Among the most extensive and reliable of all color-blind tests are those recently carried on by our own countryman, Dr. B. Joy Jefferies, who has tested 19,101 men, of whom 801 (4.18 per cent.) were color-blind; and 14,731 women, among whom he found but 11 cases. Other observers give averages varying from 1 per cent. to 8 per cent.

†Paper read before Section B, of the American Association for the Advancement of Science, Philadelphia, September 5, 1884.

was discontinued, and the drill removed. Since that time—September 8th, 1884—the well has flowed a clear, steady stream of over 10,000 gallons per day. There seems to be a continuous flow, without any gaseous agitation. The pressure will carry the water five feet above the mouth of the well in a tube, at which height it remains stationary, and ceases to flow until the altitude of the pipe is diminished.

The drill record, which is an interesting one, is as follows:

		Total.
Wash dirt,	25 feet	
Clay,	5 "	30 feet.
Soapstone,	15 "	45 "
Slate,	3 "	48 "
Coal,	2 inches	. . .
Soapstone,	15 feet	63 "
Slate,	2 "	65 "
Coal,	2 inches	. . .
Soapstone,	17 feet	82 "
Blue limestone,	3 "	85 "
Soapstone,	95 "	180 "
Soft sandstone,	5 "	185 "
Soapstone,	70 "	253 "
Brown sandstone,	25 "	280 "
Grey sandstone,	7 "	287 "
White sandstone,	25 "	312 "
Slate,	12 "	324 "
Fire clay,	4 "	328 "
Soapstone and slate,	10 "	338 "
Slate and iron pyrites,	5 "	343 "
Flint,	23 "	366 "
Flint and limestone,	14 "	380 "
Crevice,	14 inches	. . .
Limestone,	4 feet	385 "
Lime and flint,	75 "	460 "
Very hard flint,	5 "	465 "
Mixed flint and limestone,	156 "	621 "

For the last 230 feet the borings were white, mixed with gray, the pieces showing frequent specks of iron rust.

Upon analysis, the water is shown to contain the following ingredients, estimated in grams per liter:

Boracic acid,	.0378
Chlorine,	.9209
Magnesia,	.1642
Lime,	.1142
Ferric oxide,	.0078
Sodium oxide,	.7348
Sulphuric anhydride,	.0836
Sulphuretted hydrogen,	.0025
Silica,	.0163
Organic matter,	.0200
Potassium oxide,	Trace
Lithium,	Trace
Carbonic acid gas,	Undetermined

These constituents are probably combined as follows, the weights being computed in grains per U. S. gallon of 231 cubic inches:

Hydrosulphide of sodium,	.188
Chloride of sodium,	79.471
Biborate of soda,	2.204
Chloride of potassium,	Trace
Chloride of lithium,	Trace
Chloride of magnesium,	7.987
Chloride of calcium,	.787
Sulphate of lime,	.829

Sulphate of soda,	Trace
Bicarbonate of lime,	14.238
Bicarbonate of iron,	1.006
Bicarbonate of magnesia,	.305
Silica,	.951
Organic matter,	1.166
Total solids,	109.132
Sulphuretted hydrogen,	Trace
Carbonic acid gas,	Trace
Temperature,	67½°

This may be classed as a sulpho-saline water, containing borax as a rare ingredient. On comparison with other waters, we find that it is similar to some springs in Kentucky, only not as strong. These do not contain borax. The Fort Scott water is probably a mixture of streams from different depths.

NOTES ON THE FOSSIL JAW OF BISON, FROM THE PLIOCENE OF NORTON COUNTY.

BY ROBERT HAY.

Over a year ago we picked up a jaw, semi-fossilized, in the talus from bluffs in which the line of separation, or rather contact, of the Loup Fork Miocene and the Equus beds of Pliocene above, was not difficult to trace. It was therefore not possible to determine which of the two formations yielded the bone, or whether it might not have been in the soil at the top. The remarkable wearing of two of the teeth led us to preserve the specimen, and Dr. Turner, who was with us at the time, very soon afterwards found another jaw with the same wear on the teeth, and that he dug out out of the Pliocene. Drawings and descriptions of both fossils have been submitted to Professor Cope separately, and he pronounces each to be bison. The remarkable wearing of the teeth we have thought pointed to some habit of browsing and pulling of the branches of trees, but Professor Cope suggests that it was caused by eating herbage, mixed with sand and gravel, before the other teeth were cut. It is probably all that is left of the most ancient Kansas buffalo. The following are the dimensions of the first-found specimen, in millimetres:

RIGHT MANDIBULAR RAMUS OF BISON.

	Mm.		*Mm.*
Total length,	400	Length of tooth No. 3, at surface,	16
Total height,	230	Length of tooth No. 4, at surface,	23
Height at posterior extremity,	210	Length of tooth No. 5, at surface,	26
Breadth, exclusive of teeth,	67	Length of tooth No. 6, at surface,	38
Breadth, inside,	74	Height of No. 6,	23
Length of line of teeth at base,	45	Width of No. 6,	16
Length of tooth No. 1, at surface,	11	Thickness of ramus,	36
Length of tooth No. 2, at surface,	15		

A NEW METHOD OF STUDYING ABSORPTION SPECTRA.

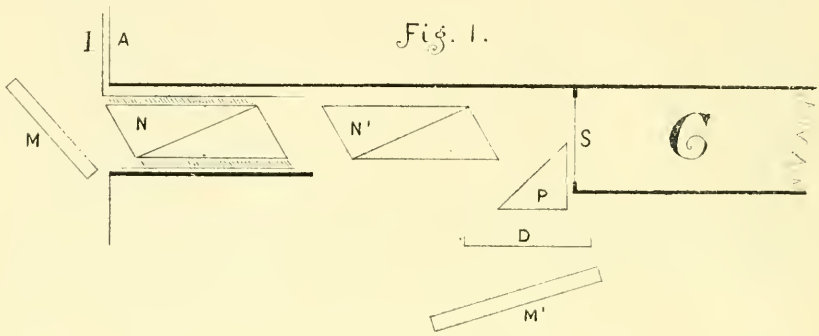
BY W. S. FRANKLIN.

This method is the one used by Prof. Edw. L. Nichols in studying the light emitted by glowing platinum,* and in his measurements of the reflection spectra of pigments.† Figure 1 in the accompanying plate represents the slit of the spectrophotometer, with attachments, as modified for the quantitative study of absorption spectra.

*American Journal of Science and Arts, Vol. XVIII, Dec. 1879.

†American Journal of Science and Arts, Vol. XXVIII, Nov. 1884.

Fig. 1.


I
A
M
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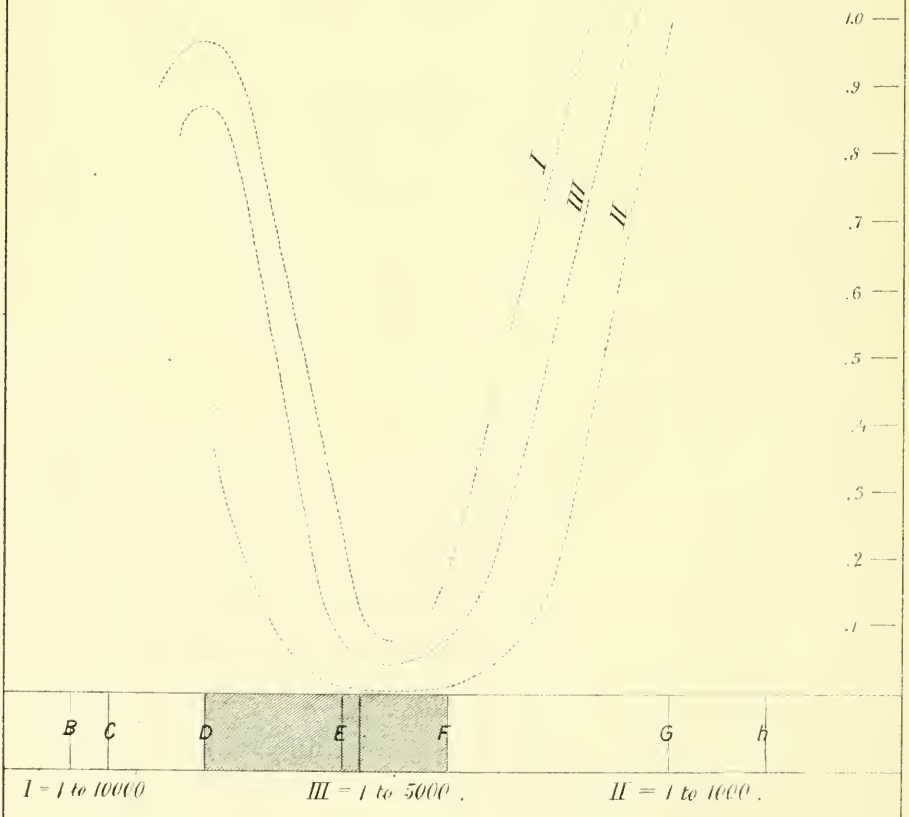
S
G
P
D
M'

Fig. 2.


1.0
.9
.8
.7
.6
.5
.4
.3
.2
.1
I
III
II
B
C
D
E
F
G
h
I = 1 to 10000
III = 1 to 5000 .
II = 1 to 1000 .

M M' are blocks of magnesium carbonate, of a pure white color. The light from *M* passes through the movable nicol *N*, the position of which is indicated by an index upon a divided circle, thence through the stationary nicol *N'* into the upper half of the slit. Thus the brightness of the direct spectrum is under the control of the operator.

The light from *M'* passes through the colored medium *D*, and striking the back of the right-angled prism *P*, is totally reflected into the lower half of the slit of the spectroscope. At the focus of the spectroscope a narrow vertical slit is placed, through which but a small portion of each spectrum is visible. These portions can be compared and made equal in intensity by turning the movable nicol *N*. Thus we can find the relative amount of light of each wave-length transmitted by the medium *D*.

Of course the movable prism *N* may be used at the eyepiece with convenience, but in the case of permanganate of potassium, the light from *M'* seemed to be partially polarized by its passage through *D*, and through the dispersing prism of the spectroscope. This was so marked in one case, that when observing the two spectra, between *F* and *G* with the movable nicol at the eyepiece, both would appear and vanish together.

The curves exhibited in the plate, (fig. 2,) show the light transmitted by solutions of permanganate of potassium, of 1 to 1,000, 1 to 5,000, and 1 to 10,000; each having a thickness of 1 cm., determined by the method described above. The shaded spectrum, given below, is taken from "The Nature of Light," by Dr. Eugene Lommel, page 175. It shows the usual method of mapping the absorption spectrum of permanganate of potassium. One can see at a glance that such maps give a very imperfect idea of the real nature of absorption spectra.

It will be seen by the above curves that a solution of permanganate of potassium is nearly opaque to yellow-green rays, while the amount of red rays transmitted by concentrated solutions is much less than that transmitted by dilute solutions. Violet light, however, seems to be transmitted equally well by all solutions. This gives dilute solutions a decided red color, while concentrated solutions approach a pure violet. It seems by this that yellow-green rays are reflected, red absorbed, and violet transmitted; but the reflection spectrum has not yet been measured, and to the eye it appears almost white.

It is my intention to study the absorption and reflection spectra of a series of compounds, for instance the chromates, permanganates, ferrates, etc., and also the salts of the metals themselves, to find if there is such relation between them as will furnish a clue to the cause of selective absorption and reflection.

One cannot study color without wondering why or how a body can show preference to wave-lengths in reflection and transmission. Why a body should reflect violet, for instance, in preference to red or yellow, is an open question.

The phenomena of opacity and transparency, and the property of absorbing all and reflecting all wave-lengths, as lamp-black and silver are capable of doing, are doubtless closely related to the subject of selective absorption. What molecular relations can there be between black and white, and opaque and transparent bodies? It is surely only a molecular difference. Can the molecules of lamp-black be so loosely hung that they sway under the impingement of any wave-length of light, while those of silver are almost immovable? Another thing, not less remarkable than this, is the color relations between the compounds of many of the elements; for instance, many of the metals of the iron group have highly-colored salts. Ferrates, chromates, etc., are particularly remarkable for their color, as are also the salts of the aniline bases.

We can understand selective reflection only by supposing that the vibrations of the molecules of some bodies deaden the wave-length in unison with them, while other wave-lengths may be either reflected or transmitted. This can be readily illustrated by sound. Suppose sound waves of different lengths to strike a screen made of wires stretched very close together and all in unison, then the wave of sound in unison with them would

be absorbed while the remaining would be partly reflected and partly transmitted. This is probably the true explanation of selective absorption in gases, and it may be the explanation of selective absorption in solids and liquids. One thing that we should expect in the case of solids is, that more than one wave-length would be absorbed, because the molecules would not have a definite rate of vibration, but would vibrate at any rate between certain limits, though with unequal facility. That is, the vibration would be stunted by the attraction of the surrounding molecules.

It is a well-known fact that gases when heated radiate those wave-lengths which they are capable of absorbing when cold. Now if the above theory of selective absorption and reflection be true, we should expect a colored solid when heated to radiate light nearly complementary to that which it reflects when cold. This *seems* to be the case with copper, which has a greenish tint when melted, but whether there is such a thing as selective radiation from solids is not certain. The only way to settle this is by a spectrophotometric study of the light emitted by colored bodies in a state of incandescence.

SOME SPECIAL TESTS IN REGARD TO THE DELICACY OF THE SENSE OF SMELL.

BY E. H. S. BAILEY AND L. M. POWELL.

[Abstract.]

At the Philadelphia meeting of the American Association for the Advancement of Science, E. H. S. Bailey and E. L. Nichols presented the results of some experiments on the special senses. The object of the present investigation is to continue these experiments with special attention to the sense of smell. It is doubtless true that, in the process of smelling and tasting, actual contact with the substance must take place, and the substance must be soluble, or must be floating in the air in minute particles.

As we wish to form some idea in regard to the delicacy of this sense, and the effect of education upon it, and to compare it with chemical tests for the determination of substances, we have used as test solutions the following:

Oil of lemon, 1 part in 4,000 parts of water; oil of wintergreen, 1 part in 2,700 parts of water; Prussic acid, 1 part in 512 parts of water; caustic potash, a dilute solution.

The oils were obtained in solution in water by grinding with magnesia, and filtering. All the solutions were successively diluted so that each bottle was one-half the strength of the previous one in the series, and the dilution was continued till it was impossible to detect the substances by smell. Tests were made by 21 females and 27 males, each one attempting to classify in four groups, as above. Although the number tested is too small to justify an absolute conclusion, yet it is valuable as indicating probable results. The average was as follows:

AMOUNT DETECTED.

	Prussic acid.	*Oil of lemon.*	*Oil of wintergreen.*
Average of 27 males,	1 part to 112,000 of water.	1 to 280,000	1 to 600,000
Average of 21 females,	1 part to 18,000 of water.	1 to 116,000	1 to 311,000
General average,	1 part to 65,000 of water.	1 to 198,000	1 to 455,500

Three of the males were able to detect one part of Prussic acid in about 2,000,000 parts of water. Two of these were persons engaging in occupations favoring the cultivation of this sense. Careful chemical tests were made for Prussic acid, but it was not detected below the bottle containing 1 part HCN in 131,000 parts of water. More delicate tests can probably be made by the use of the microscope.

Dr. Otto regards the sense of smell as one of the very best means of detecting this acid. Orfida, Lounsdale and Christison coincide with him, and our investigation points in the same direction. Profs. Wormley and Taylor, however, consider a chemical test more reliable and delicate.

It will be noticed that the sense of smell seems to be more delicate in males than in females. This result coincides with that previously obtained by Profs. Bailey and Nichols, while the females possessed a more delicate sense of taste.

We are able to detect smaller quantities of substances with which we are perfectly familiar, as oil of wintergreen. Without doubt education has much to do with the delicacy of this special sense, for in addition to the fact that persons who have occasion to use the sense are more skillful, we have noticed that some who at first cannot tell Prussic acid from ammonia soon learn to distinguish readily between them.

IS THE RAINFALL OF KANSAS INCREASING?

BY PROF. F. H. SNOW, OF THE UNIVERSITY OF KANSAS.

In the present paper attention is called to the fact of an increase of rainfall rather than to the various theories which have been advanced to explain such increase, or to show that there ought to be an increase.

Geologists, physicists and astronomers are harmonious in accepting it as an established fact that the earth, in common with all other worlds in the universe, is slowly passing through a series of changes from an original nebular mass of intensely high temperature to an entirely solid mass of very low temperature. The sun and the larger planets of our system illustrate the early stages in this series of changes. The earth is in an intermediate condition between the two extremes, and the earth's moon represents the extreme of entire solidity, in which the waters and the atmosphere which once covered and surrounded its surface have been absorbed within its mass, and a very low temperature continually and everywhere prevails. There can be no doubt that the earth is very gradually approaching the moon's condition, and that sometime in the far distant future, how many millions of years hence no man can determine, its atmosphere and surface waters will entirely disappear and a low temperature prevail, even in its tropical regions, far exceeding the cold of the coldest Arctic winters in the present age. There can be no doubt, therefore, that, considered with reference to long periods of time, the rainfall of the earth is diminishing. If prehistoric man, 10,000 years ago, had kept scientific records of the rainfall of his time, and it were possible to compare these records with those of the present day, it would be found that a considerable reduction of the average annual precipitation has been made in the period named. Even a thousand years might show a perceptible decrease. But in so short a period as the lifetime of a single generation of men, or even in an entire century, the average annual rainfall of the entire globe has probably been reduced to so slight an extent as to be expressed by a very few hundredths of an inch.

Yet, although the entire movement is in the direction of a reduction of the rainfall, there are without doubt local oscillations in consequence of man's influence upon nature, which in some cases result in a more rapid decrease than would otherwise be accomplished by the unaided forces of nature, and in other cases within limited areas secure an actual increase in the rainfall. I believe the State of Kansas furnishes an apt illustration of a change of the latter sort. Here the circumstances have been extremely favorable to such a change. Thirty years ago the Territory of Kansas was not occupied by the white man, and if we except a few acres cultivated by the Delaware Indians, no portion of her soil had been turned up by the plow. Her entire area was included

within the vast and almost unknown region of the "Treeless Plains" and the "Great American Desert." During that brief intervening period, more than 1,000,000 people, chiefly of the agricultural class, have taken possession of her domain, and have already brought her to the very front rank of the States of the Union in the extent and value of her agricultural products. History affords no other instance of the permanent occupation of so extensive an area previously unoccupied by man, by so large an agricultural population in so short a space of time. Here certainly, if human agency could anywhere affect climate, would such an effect be produced. Here, assuredly, if settlement ever increases rainfall, will such increase be most marked and most unmistakable. That such increase has actually taken place, I believe to be established beyond a doubt. It is a circumstance peculiarly favorable to the determination of the point in question, that although the general settlement of Kansas by cultivators of the soil is of such recent date, reliable observations upon the rainfall had been made at the military posts upon her eastern borders for a sufficient period to make possible a satisfactory comparison between the rainfall before settlement and after settlement. The records at Fort Leavenworth cover the longest period, and enable us to compare the nineteen years immediately preceding the occupation of Kansas by white settlers with the nineteen years immediately following such occupation. During the first period the average rainfall was 30.96 inches; during the second period it was 36.21 inches, giving an average increase of 5.21 inches per annum. Here we have an increase of nearly 20 per cent. in the rainfall, under such conditions as to necessitate the inference that such increase is chiefly, if not entirely, produced by causes connected with the introduction upon a large scale of an agricultural population into a previously uncultivated territory. The Fort Leavenworth records cover so long a period of time (nearly forty years), that the increased average of the second half of the period cannot be attributed to a mere "accidental variation." In the issue of *Science* for April 18, 1884, it is stated that "the supposed increased rainfall in the dry region beyond the Mississippi is not borne out by the returns of the Signal Service." But the records of the Signal Service, upon which this statement was based, include a period of only twelve years of observation, from 1871 to 1882, which is undoubtedly too short a period for either establishing or disproving the fact of a "secular" variation. We have also called attention to the fact that causes which have a tendency to secure an increased rainfall, have here been put into operation upon a grander scale than in any other portion of the dry region west of the Mississippi.

But the fact of an increased Kansas rainfall does not rest entirely upon the Fort Leavenworth observations. There are other stations in Kansas whose records cover a much longer period than that of the longest established regular station of the Signal Service. There are the twenty years' records of the United States military post at Fort Riley, the twenty-four years' records of the State Agricultural College at Manhattan, and the seventeen years' records of the State University at Lawrence. If these several periods of observation be divided into two equal parts, in each case it is found that the average rainfall of the second half is notably greater than that of the first half. At Fort Riley the increase amounts to 3.05 inches per annum, at Manhattan to 5.61 inches per annum, and at Lawrence to 3.06 inches. Expressed in per cent., the rainfall of these three stations has increased in the second half of each period of observation, at Fort Riley, 13 per cent.; at Manhattan, 20 per cent.; and at Lawrence, over 9 per cent. If this increased rainfall could be shown by the records of a single station only, or if the several stations with sufficiently long periods of observation exhibited discordant results, some indicating a decrease while others indicated an increase, or if even a single station indicated a diminished rainfall, the fact of a general increase would lack satisfactory demonstration. But the entire agreement of the four stations, whose records have value in a discussion of this question, seems to establish beyond doubt the fact of an increased rainfall in the eastern half of Kansas.

There can be no reasonable doubt that the general settlement of the western portion of Kansas would have a similar effect upon its rainfall, but it is not reasonable to expect that western Kansas will ever boast of a rainfall equal to that of eastern Kansas. So long as the eastern half of the State remains to the east of the meridian forming the western boundary of the Gulf of Mexico, the south winds will cause it to receive much larger supplies of vapor, for condensation into rain, than will be received by the western half of the State, which lies beyond the immediate track of the vapor-laden winds. It must be remembered that climatic changes are exceedingly gradual, and a rain deficiency or excess for a single year, or for two or three years in succession, must not be considered as invalidating the law of general averages. Neither should the fact that the rainfall upon the whole is increasing, induce settlers to break lands in the western third of Kansas with the expectation of successfully raising the same crops as in eastern Kansas. Such settlers will surely be disappointed. It is even doubtful if paying crops of any kind can ever be continuously produced in that region. With an average before settlement of about 15 inches per annum, the same percentage of increase as has been made in eastern Kansas in thirty years would give less than 18 inches per annum—a quantity entirely inadequate to maintain successful agriculture.

OBSERVATIONS OF NOVEMBER METEORS.

BY R. H. SHORT.

On the 15th of this month, at 2 o'clock P. M., I was examining the sun's disk with a glass giving a power of about 45 or 50 and embracing a field of view of three degrees, to locate the relative position of the sun-spots then visible. After looking at the sun for some five or six minutes, I saw a bright point of light, leaving no train that I could see, cross the middle of the field. The sun was directly in its path; nevertheless it was visible both while entering and leaving the field. The time it occupied in crossing the field was a small fraction of a second.

At the time I did not think much about it; I did not think a meteor could be seen at all near the sun, much less to appear to cross its disk. About five minutes later, another point crossed in almost exactly the same place. The apparent brightness and rate of motion were also the same. I then left the telescope and looked all around the building, to see if there was anything that could produce such an effect by coming between the glass and the sun. I was hardly willing to believe that these two objects were meteors, yet was not able to account for the phenomena in any other way.

Being still undecided, I concluded to watch the sun for a while to see another if I could. I had been looking for at least ten minutes, when a meteor, fire-ball, or something of the kind, crossed the field one-half of a degree from the sun. Its motion was slow, compared with the first, but the direction was the same in all three cases, namely, from southeast to northwest. This last was more distinct than the others, perhaps because of its distance from the sun's disk. Its apparent diameter was about that of Venus. It crossed the field (three deg.) in not less than one-fifth of a second. Its brightness was about one-half that of the sun, and color a shade of yellow. It left a train visible after the meteor had left the field. A few minutes after, clouds obscured the sun and also the western sky. It remained cloudy until about 5 o'clock. From 5 o'clock until sunset, nothing comparable to meteors was seen.

Between 8 and 9 o'clock P. M. of the same day, I saw three bright meteors follow, as nearly as I could judge, the same course as those that were seen in daylight. The radiating point of these last three was from a point in the southern part of Andromeda.

The following notices of extraordinary meteors are from "Kirkwood's Meteoric Astronomy":

On the 15th of November, 1859, between 9 and 10 o'clock in the morning, an extraordinary meteor was seen in several of the New England States, New York, New Jersey, District of Columbia, and Virginia. The apparent diameter of the head was nearly equal to that of the sun, and it had a train, notwithstanding the bright sunshine, several degrees in length. Its disappearance on the coast of the Atlantic was followed by a series of the most terrific explosions. It is believed to have descended into the water—probably into Delaware Bay. A highly interesting account of this meteor, by Prof. Loomis, may be found in the American Journal of Science and Arts, for January, 1860.

On February 6th, 1818, one was seen in England at 2 P. M., shining with a light equal to that of the sun.

On November 12th, 1828, a meteor was seen in the sunshine at Surg, France.

Humboldt, after describing the great shower of 1799, witnessed by himself and Bonpland, states that "the phenomenon ceased by degrees after 4 o'clock and the bolides and falling stars became less frequent, but we still distinguished some toward the northeast a quarter of an hour after sunrise."

June 17th, 1779, about midday, the eminent French astronomer Messier saw a great number of black points crossing the sun. Rapidly-moving spots were also seen by Pastorff on the following dates: October 23d, 1822; July 24th and 25th, 1823; October 18th, 1836; and on several subsequent occasions the same astronomer witnessed similar phenomena.

Another transit of this kind has been seen quite recently. On the 8th of May, 1865, a small black spot was seen by Coumbary to cross the solar disk.

Thus we have well-authenticated records of meteors having been seen as bright bodies in bright sunlight, and that they have been seen far beyond our atmosphere as black spots on the sun's disk.

The November meteors proper from Leo were not very numerous this year. On November 13 no meteors from Leo were seen. Mr. W. S. Franklin watched during the latter part of the night of the 13th, and I the first part. On the 14th, 15th and 16th the weather was very pleasant, so Mr. Franklin and myself watched for Leonides from 12 o'clock, midnight, until morning, Mr. Franklin watching one part of the sky, and I the other. We recorded at least thirty that could be traced to Leo.

ON THE PHOSPHORESCENCE OF CHLOROPHANE FROM PIKE'S PEAK.

BY PROF. G. H. FAILYER, STATE AGRICULTURAL COLLEGE.

During the summer of 1881, the writer collected fluorite of various colors—white, green, rose and purple—in the Pike's Peak region.

Having recently had occasion to examine its property of phosphorescence, he found that it exhibited phenomena so unlike what he had anticipated from his knowledge of the phosphorescence of fluorite, that he made a somewhat minute examination of the specimens. It was first observed that when fragments of the fluorite—these fragments being indifferently fine powder or thin pieces an inch across—were dropped upon a metallic plate heated to a temperature considerably below redness, a green light was soon emitted. The green light deepened in tint as the temperature increased, and gradually gave place to light of a violet color. This, in turn, became of deeper hue, and at last faded. It is well known that fluorite phosphoresces when heated, that some specimens give white light, some green, others violet or purple; and that when brought to a sufficiently high temperature they all lose the power to phosphoresce. But this change of color as the temperature is raised was entirely unexpected, and I have searched the books in vain to find mention of it. The September, 1884, *Am. Jour. of Science*, contains

an account of a chlorophane from Virginia and one from Siberia, which passes from light green to a fine emerald green as the temperature rises, but no mention is made of a change of hue, although the mineral was placed on a live coal. I was sufficiently interested to investigate further. If the fragment be cooled when emitting either the green or the purple light and be heated again, the light which it was giving when cooled will return. Thus, if giving purple light and then cooled and again heated, it does not now first give the green, but emits the purple as soon as it reaches the temperature at which it became non-luminous. It was found also that the several specimens became luminous at temperatures ranging from 100°–110° C., and that the purple violet tint appeared at 170°–180° C. It was impossible with the Hg. thermometer to measure the temperature at which the fluorite lost the power of phosphorescence, but it was below a red heat in the form of the experiment tried by me. It is by no means a matter of indifference whether the temperature rises slowly or rapidly in exciting phosphorescence. A piece of the mineral was broken into two nearly equally portions. One of these was heated rapidly, the other slowly. That rapidly heated emitted a fine green which was succeeded by a distinct and moderately deep purple. The slow heating was accomplished by placing the mineral on the edge of a metal plate heated in the center by a gas flame. It became faint green as soon as it became warm. Presently the light entirely disappeared; on moving the mineral to a warmer part of the plate, the green phosphorescence again appeared, to disappear and reappear as before. At length it lost the power of phosphorescing by increasing the temperature. In other words, its power to emit light was gone. In this case of slow heating only the faintest approach to a violet tint was perceptible. I have no doubt that by careful manipulation it might have been made to yield pure green light only; and indeed, I believe that if the temperature be very slowly raised these specimens of fluorite would ultimately lose the power of giving out phosphorescent light at any temperature without at any time becoming luminous. Experiments upon this point have not been entirely conclusive, but have indicated this result. If it be true that by slow heating, specimens which more rapidly heated give both green and purple light, yield only green light, and that if very slowly heated no phosphorescent light will be given out however high the temperature be raised, then the molecular change, whatever it be, that causes phosphorescence, and which when effected precludes the recurrence of the phenomenon, may be produced so slowly as to emit no light whatever.

The specimens of fluorite from Colorado, like those from the localities previously mentioned, became phosphorescent by friction, best against each other, but also against other minerals and metals. The friction need not be very great to elicit light. This result is well shown by holding a piece of the mineral on a grindstone. The abraded powder remains luminous for a time, making a streak of light as the stone revolves. Other specimens of fluorite in our cabinet do not show this change of color, and do not become phosphorescent by attrition.

CHRISTENING AMETHYST MOUNTAIN.

BY J. SAVAGE.

Amethyst Mountain is situated upon the East fork of the Yellowstone, in the National Park, and was so named by Prof. F. V. Hayden during the summer of 1872, under the following circumstances:

The main party of Hayden's Geological Survey were camped in Cache valley, near the mouth of the East fork of the Yellowstone, while Prof. Hayden, Sir Wm. Blackmore, our English guest, and a few others, made a hurried trip to the headwaters of Clark's

fork and Shields's river. This trip took them up the valley of the East fork to its source, and occupied some three or four days.

During their absence, the remainder of the party were employed in exploring the vicinity of our camp. In company with Dr. Platt, of Waterbury, Conn., I went up the East fork some six or eight miles, and, as was our usual custom, climbed a rather high mountain, south of the river a couple of miles, perhaps. Here we found the summit covered with petrified trees, many of which were lying prostrate — some thirty or forty feet long — upon the surface of the ground. Upon another portion of the summit were many other petrified trees still standing upright where they grew; some were of large size, and afterwards were found by actual measurement to be ten feet in diameter. Many of these fossil trees had been covered with volcanic material, and were seen standing out from perpendicular cliffs, where the volcanic material was weathering away. We hitched our saddle horses to upright stumps of these trees and ate our dinner, and returned to camp laden with the product of this weird mountain-top.

The next day, August 1st, in company with Prof. Wakefield, of Hiram College, I returned to this same peak, and continued my explorations. It was during this day's search that I turned over a large section of a petrified tree which had been hollow, but was now filled with beautiful crystals of amethyst. It was a beautiful sight, and one long to be remembered! We filled our saddlebags and pouches with these crystals, and started off for camp. It was a Mr. Sloane — a graduate of Columbia College — who first met us, and seizing a good-sized specimen, went shouting through camp, "Amethyst! Amethyst!" The entire camp gathered around us in admiration of the crystals, and each one secured a goodly number of crystals for himself.

The next day, Dr. A. C. Peale, our mineralogist, and several others of the party, returned with us to the peak, and found other parts of the same tree, and still other specimens of amethyst from other trees; and from this time forth, *Amethyst* Mountain occupies its place upon all our late maps. It may be interesting to add, that the crystals which were exposed above the ground to the sunlight had entirely lost their violet color, and were simply quartz crystals, while those below the surface, upon the same slab, had retained their color perfectly.

THE LAST SUBMERSION AND EMERGENCE OF SOUTHEASTERN KANSAS FROM THE CARBONIFEROUS SEAS, OR THOSE AFFECTING THE CARBONIFEROUS FORMATION IN KANSAS.

BY E. P. WEST.

The country along the line of the Southern Kansas Railway all through southeastern Kansas and extending westward to Harper, the present terminus of the road, is unsurpassed in beauty and the fertility of its broad fields and valleys. It is said, and truthfully, to be the paradise of the husbandman and the pasturist; and it is no less so of the geologist, the poet, and the artist. Whoever has traveled over the line of this road could not have failed to observe the picturesque and poetic beauty everywhere meeting the eye. Symmetrical mounds rise from the broad plains and valleys, as if by the work of magic, and terraced cliffs, terrace rising above terrace in solemn grandeur, environ the road. Sometimes the cliffs are circular, forming vast amphitheaters, extending back for miles. Those mark the last emergence of southeastern Kansas from the carboniferous seas, and bear unmistakable evidence of powerful and persistent forces which, though perhaps comparatively brief, have left their impress boldly written on every feature of the country. Water-worn pebbles, commonly known as gravel beds, are found in the channels of streams, in the valleys, under the soil, and over the highest mounds and ridges all over

the country. They are encountered north of Ottawa, and extend southward into the Indian Territory, westward to beyond Burlington, and eastward into the State of Missouri. How much beyond the limit indicated they extend I am unable to say, but it is probable that their range is much wider. This, however, can only be determined by an exploration of the adjacent country. Independent of their scientific significance, these beds are important in an economic point of view, affording free underdrainage, and supply good and convenient material for road-making. Along the brink of mounds and cliffs, and often for a considerable distance removed from them, as well as on top of the highest ridges and mounds, at and near the surface, the rocks often stand vertically to the plane of stratification, or incline at various degrees from this line. This is notably conspicuous in many places.

Not unfrequently old landslides are to be seen projecting from the mounds, or the brinks of cliffs, and extending out for hundreds of feet. Indeed the whole country wears the appearance of having once formed the bed of shallow seas, divided into numerous channels of various widths. Some of the cliffs, during the recession of the water, perhaps, formed coast lines, while the higher lands may have been low islands. Such is the condition of things conspicuously marked over the entire area named. To what cause is this great work to be attributed? It could not have been done by rivers, for the pebbles, though water-worn, are too widely distributed for the work of the broadest of such streams. It was not effected by glaciers, for the vast landslides, the conformation of the mounds and cliffs, the vertical position of the rocks where the stratification has been disturbed, the absence of erratic rocks, and the want of the commingling of the local rocks, all preclude this idea. If it had been caused by glacial action, there would have been an intermingling of all the rocks torn down, indifferently. This, however, is not the case anywhere in the district observed. Neither are the beds composed of altered drift, for if they were so they would be homogeneous in their general distribution; but this is not found to be the case, for in some localities they are composed of chert alone, while in others they contain small broken fragments of sand-rock alone: in each instance identical with the adjacent local rocks. No erratic, trap or igneous rocks, or limestone, is anywhere to be found intermingled in the beds. The absence of trap and igneous rocks is to be accounted for from the fact that the glaciers did not extend so far south. The absence of limestone, though the prevailing local rock of the country, will be explained farther on. It was not caused by volcanic action, upheaval, or folding of strata, for the under strata rest undisturbed. Though evidently not caused by any of these agencies, the mounds, the terraces, the cliffs, the water-worn pebbles, and broad plains and valleys are conspicuous, grand and picturesque facts which stand out in bold relief in the entire district, and prove a widespread destruction of its former surface. The whole country, indeed, has been denuded for from at least fifty to two hundred feet in vertical thickness, leaving the more impregnable mounds and cliffs, the pebble-beds, and broad plains and valleys, standing monuments to bear witness to the general destruction which, in a past age, took place. The power which caused it must have been great and persistent, and can only be determined by the evidence it has itself left impressed on the field of its operations, and which, if correctly read, will unerringly lead to its detection. This reading points clearly and unmistakably to water aggregated in broad and shallow seas as the author of the stupendous work.

The deposits of pebbles, clays, and soils; the great landslides; the mounds, cliffs, and terraces, and the inclination of the disturbed rocks, marking the country so persistently and conspicuously, could have been caused in no other way. These seas were no doubt connected with an ocean, or deeper and more extended waters, lying to the southward and westward; but at what era of geological time is somewhat uncertain, except that we know that it must have occurred since the Carboniferous age, for the upper Coal-measure and Permian rocks are those destroyed.

Coëxtensive with this area of devastation, as far as I have had an opportunity to examine it, and, I presume, coëxtensive with its entire limits, there is scattered over the country—resting upon the surface or buried under recent alluvial deposits—silicified wood which grew at a time intermediate between the carboniferous vegetation and our recent forests. The carboniferous wood is invariably imbedded in the stratified rocks, while this intermediate wood is invariably upon the surface, or resting under recent alluvial or vegetable deposits. This would indicate that portions of Kansas, at least, were covered with forests at the time this widespread destruction began, and subsequent to the Carboniferous age, portions of which must have been swept away and destroyed by the submergence of the country, while other portions of it, where the conditions were favorable, were silicified in the mineral waters of the seas, and left scattered over the old sea-bed in positions at or near where they are now found, when the land, for the last time, in southeastern Kansas, emerged from the water.

The petrified remains of this intermediate forest, when its limits are fully known, may give some clue to the time of this era of destruction. To the westward, in the region of middle Kansas, the bones of species of animals now living, and the remains of man, have been found buried under alluvial deposits of wide occurrence and at considerable depths below the surface. If the intermediate fossil wood should be found, as it probably will be, associated with these buried remains, it will render the probability great that this era of waste was comparatively recent, and that man may have reposed under the shade of the forests which preceded it, and which were involved in its devastations. But there is an equal probability that it may have occurred at an earlier date of the world's history.

This last era of submersion in Kansas seems to have been one of destruction, for no fossil remains of sea life seem to have been left to indicate the age of occurrence; and to determine this a resort must be had to preceding life, or synchronous air-breathing animals which may have been carried out by ocean currents and buried under their deposits.

The absence of life, or the fossil remains of life, of this era, is not to be wondered at when we consider the widespread destruction which took place in it. All of the time, rocks, which were torn from their beds, were destroyed utterly, either by the chemical action of the acids in the water, or ground up by the attrition caused by waves and currents—or, most probably, by both these causes combined—and carried away, in part, to distant and deeper waters, and in part left to form the soils of the local valleys. The more enduring silica was rounded by the action of the water, and left in the beds so widely distributed over the country. Where the destroyed strata were composed of limestone alone, no pebbles are to be found, but where the lime-rocks contained masses of chert, or where the strata were composed of chert entirely, the pebbles are found, and the beds vary in thickness in proportion to the amount of material torn down. Where the destroyed strata are in a locality of sand-rock, and composed of sand-rock alone, the gravel-beds are composed of their fragments alone. There may have been, and undoubtedly was, some drifting together of the pebbles, caused by the waves and currents of the sea, but in the main they are confined to the locality where they were torn down, and are nowhere of any considerable thickness. There are now in the museum of the University of Kansas perhaps a hundred specimens of fossil shells, collected from these beds at various and widely-separated localities, identical with the undisturbed fossils of the respective localities where they were found, and which prove conclusively, if additional proof were needed, that the pebbles composing these beds are but the more enduring parts, or silica, entering into the composition of the local rocks destroyed. The silica, being impervious to the acids which aided the destruction of the lime-rocks, remains imbedded where showered down from the general ruin, and as left when the land emerged

from the water, except where the beds have been since locally altered, to a limited extent, by rivers and other streams of water cutting through them.

I am aware that erosion and changes in the elevation of land, of continental extent, occurred during Post-Tertiary time, but it is not probable that all the changes happened at the same time, and we must look to the respective changed localities to determine the relative ages when this work was done.

In this paper I have considered southeastern Kansas only, and have attempted to sketch the condition of things wrought out by natural forces in it.

IN THE DACOTAH.

BY ROBERT HAY.

Across central Kansas, from north to west of south, stretches a belt of country, marked in ravines by rugged sandstone rocks, and by long-rounded slopes on the prairie. This belt belongs geologically to the lower part of the Cretaceous system, known as the Dacotah formation. To travelers on the Central Branch Railroad, passing through Washington and Cloud counties, these sandstones are conspicuous objects. On the line of the Kansas Pacific, the same sandstones, underlaid by colored shales, make the wild country from Bavaria by old Fort Harker to Ellsworth. On the Santa Fé Railroad, a single hill standing out in the broad valley of the Arkansas, covered on its precipitous front with names of visitors—archdukes and naturalists—a hill of varied sandstone, capped with chalk, is the sole mark left by the tremendous erosion of a million years that here too the Dacotah formation occupied its place. Away north in Nebraska and to British America, away south in the Indian country and Texas, the same sandstones appear. The same, but varied—varied, but still the same.

At our northern State line, the surface-development of the Dacotah is about thirty miles across, forming the bluffs of the ravines on the west side of the Little Blue, and disappearing under the Inoceramus limestones of the Benton series in the west of Washington county, north and south of Haddam. Further south, the belt is wider, in some places exceeding fifty miles. This is probably due to a greater slope of the surface in the south, in past ages, causing greater erosion of superincumbent deposits.

The hill in the Arkansas valley is forever wedded to a tale of terror. It is the famous Pawnee Rock. But a little shred chipped from it tells another story. It is marked with the remains of an ancient flora. Further north, in Ellsworth county, are ravines with precipitous sides, on some of which a lost race has carved hieroglyphics of war and travel; and there are huge single rocks, like giant pulpits, standing out and alone. In Ottawa county are the worn pinnacles and crags of Rock City. In Washington county the bold sandstone cliffs are seen resting on permian limestone, while their upper surfaces have been ground by the huge hard boulders of the glacial age. And in all these places are the relics of the Old World flora leaves—dicotyledonous leaves. Other of our counties have them—Clay, Cloud, Saline—and they are found away north and south far beyond our borders. Professor Mudge and others have estimated the thickness of the Dacotah at about five hundred feet, and this thickness is composed mainly of sandstones, those near the top in most of the exposures we have seen, being light-colored, and the lower ones dark brown or red. In some places it is blood red, streaked with yellow; and when the sun shines on it we have a gorgeous glory. The coloring-matter is largely composed of some compound of iron, and in places this has oxidized in most curious forms, suggesting by their vitreous surfaces the action of fire. In many places we have picked up specimens with a botryoidal surface not to be distinguished from kidney hematite from Europe and elsewhere. Then there are nodules

of all imaginable shapes and sizes, rough vases, large troughs, bunches of fruits, hollow stems. It is easy to call these concretions. When we have said that, it is all plain! Is it? What is a concretion? A gathering together of somethings. What was the thing and the force that concreted and arranged the material of these balls, pipes, geodes? We have handled several thousands of these Dacotah concretions and examined many from other formations, and notwithstanding their multiform character we have come to the decided opinion that the origin, the starting point of the great majority — say nine-tenths of these in the Dacotah — is some organic form, mostly vegetable, about which the other material has been arranged in layers more or less concentric. A seed, a fruit, a nut, a twig, a snail-shell, a naked gasteropod, a spider, or a group of any of these, dead and decomposing; their organic juices, acids or alkalies have acted on the alkalies, acids or metals in the silt sand, or ooze about them, and so formed layers of iron rust, or chrome, clay or sand, which may have again changed and assumed the texture which we now find. We have concretions which can be arranged in a series passing from most fantastic forms through definite grades to those which are undoubted carpoliths, and as such are figured by our best fossil botanists.

The fossil remains of the Dacotah sandstones but rarely illustrate the fauna of that age. In two localities, over limited areas, marine shells of some score species have been found, and at one place, in Ellsworth county, we have a bivalve, probably estuarial, among the mass of leaves. From a well near Delphos, in Ottawa county, we have a mass of pyrites containing casts, both internal and external, of gomatites. Another compact arenaceous mass seems to be a saurian scapula; and the books tell of another saurian, from the clay near Brookville.

But if there be paucity of faunal remains in the Dacotah, there is no scarcity of the flora. The leaves are simply innumerable, and represent hundreds of species of plants, from the humble weed to the lofty tree. Fruits, clearly determinable as such, are however rare, and twigs, branches and trunks are rarer still. In the north of Dickinson county, one well-defined trunk has been taken out in sections and carried off by different collectors, and small branches are not scarce in that immediate locality. We have thought that some of the silicified and calcified logs of the Benton formation are probably Dacotah trees, suddenly killed at the end of the period. Fruits, certainly recognized, are those of juglans, prunes, and some other unnamed carpoliths.

The leaves described and figured in Lesquereux's "Cretacous Flora" belong to 130 species, while his new volume will have 17 additional plates of new species, and other species have been discovered this year. It is these leaves that have made the Dacotah famous. They are the earliest dicotyledons. Eighteen years ago Prof. Swallow, in the absence of fossils, ranked these sandstones as older than the Cretaceous system. When the geologists of the National Survey found the fossil leaves in Nebraska, Prof. Marcon pronounced the formation to be Tertiary. Now, certainly known to be Cretaceous, it is famous for the leaf forms distinctly allied to, and some identical with, modern species. Among the more conspicuous genera are Salix, Quercus, Magnolia, Sassafras, Juglans, Laurus, Ficus, Fagus, Liquidambar, Sequoia, etc., etc. As in our modern forests, the trees grew in groups, willow predominating in one locality, sassafras in another, and so forth. Lesquereux noticed this fact more than ten years ago. The leaves are distributed throughout almost the entire vertical extent of the Dacotah formation. They are found in the bottom sandstones and the shales beneath, as well as in all but the highest arenaceous beds of the series, where they are scarce, if not absolutely lacking. This is a vertical distribution of over 400 feet. It follows from this, that the forests, which supplied these masses of leaves, flourished through the period necessary for the deposition of over 400 feet of sandstone through the immense Dacotah area. If we go to a modern seaside, where the tides are strong, we may notice the layer of sand deposited

on some estuarian flat between ebb and ebb. It is possibly a small fraction of an inch between spring tides. In one place, in Ellsworth county, a deposit, filled with leaves from bottom to top, is from ten to fifteen feet thick. The leaves not huddled together, but evenly distributed, and often lying perfectly flat and straight. It was a time of what might well be called permanent conditions of climate. Yet there was all the while going on a gentle subsidence of the whole region, and this subsidence was the certain prelude of change, and the change came at last, and changes many have been since then.

We have, in collecting specimens of the Dacotah flora, encountered a difficulty in identifying species, which lies not only in the way of amateurs, but is also a trouble to specialists. The difficulty we refer to is that caused by not readily recognizing what particular form of fossil we have found, and which form is figured or described in the books we use. About fossil leaves, we remark that there are five forms, any one or two of which may be presented to us by a particular specimen, and all of which, for each species, should be in position in a typical cabinet.

1. There is simply the impression that the leaf may have left on the material with which its *upper* surface was in contact.

2. The similar impression made by the *under side* of the leaf.

3. The leaf itself may be petrified, and we may see the *upper* surface of it.

4. The petrified leaf may be adhering by the upper surface, and we may see the *under* side.

5. The leaf itself may all have been dissolved away without other material taking its place, leaving a thin cavity between the impressions of the upper and lower sides which a tap of the hammer may lay open.

These same forms, essentially, if not numerically, occur for all kinds of fossils. A locality a few miles from Lawrence gives us beautiful internal and external casts of a gasteropod-pleurotomarid sphærulata, as well as the fossil itself. We have on the table a plaster cast taken from the external impression of a Dacotah bivalve. Having often experienced the difficulty above referred to, and sometimes found specimens of which the form was readily distinguishable, we have thought it worth while illustrating this point by some experiments in plaster with leaves from trees now growing in Kansas. And we have a few fossils illustrating some of the forms. Those fossils best illustrating forms three and four are those of thick coriaceous leaves.

BUILDING STONE.

In Ottawa and Washington counties, the Dacotah yields a heavy, dark-brown stone, which can be readily worked, and where used in squared blocks makes a very handsome building material, and is well set off by sills and corners of the neighboring Benton, or Permian, limestone. The rough, ferruginous sandstones, and even the softer varieties, supply building material of various qualities all through our Dacotah region.

COAL.

In several counties—Washington, Republic, Lincoln, and Russell—seams of an inferior quality of coal have been found. It is lignite, having much pyrites and a large quantity of ash when burned. It is, however, of some use as household fuel where the thickness of the seam is sufficient to pay for working it. Professor Mudge indicates that there is *one* horizon for *several* of these seams. It would be valuable geological service to determine the position of that horizon, and if it was a continuous seam now broken by erosion, or whether the localities indicate a series of islands or basins. Though the term lignite indicates the presence of wood fiber, yet we have no idea that any considerable part of this material was wood, for it has been shown conclusively by experiments, the results of which are confirmed by our experience of modern forests, that wood fiber, especially of the higher kinds of trees, is not preserved in the conditions under which coal was formed, so well as material of the leaves, stems and seed vessels of the under-

growth of ferns and other plants of the lower vegetable orders. But the immense numbers of leaves in the Dacotah sands indicate forests on the land, whose undergrowth through ages must have left a carbonaceous deposit which, entombing and preserving some trunks, may well be the lignite of to-day. And here is another problem. Was there not a lignitic stratum formed in immediate proximity to every thick deposit of leaves? In other words, may the leaf deposits be taken as "*indications*"—in the miners' sense—of lignitic coal? An extended examination of many localities would have to determine this.

CELESTITE.

Just outside Salina, on the east of the town, is a hill of Dacotah sandstone. On the southeast this hill is cut into a bold front by the Smoky Hill river and the excavations for a flouring mill. This front shows the upper layers of the permo-carboniferous rocks and shales. A few miles south, the cavities in these upper layers yield beautiful crystals of celestite—the discovery of which is to be credited to our friend Mr. Warren Knaus. In Washington county, northeast from the county seat, a bold bluff overlooking Mill creek is capped by the sandstones of the Dacotah, and is marked at a lower level by a thick ledge of permian limestone which is again underbedded with gypsum. At the west end of the bluff the Dacotah is eroded, and the permian ledge is quarried, and here the writer found last spring the beautiful flat crystals of celestite, such as were found in a similar position in Saline county. Another problem! We know that sea water contains, besides other salts, a supply of strontia. Were those crystals of the upper permian cavities deposited by infiltration from the Dacotah sea, and may we not expect in this horizon somewhere a supply of this mineral which will have a commercial value?

ARTESIAN WELLS.

We are led to think from many observations that an important if not the chief item in the economic value of the sandstones of the Dacotah will turn out to be their capacity of holding water and supplying it to a large part of west-central Kansas, beyond their area of surface development. The dip of the strata appears to be mainly west and by north. We pointed out a year ago that there are indications that the rocks of western Kansas have an easterly dip. Putting these facts together, we infer that somewhere between the two regions there must be a synclinal trough, and along the line of that trough water will mostly be found in the sandstone in sufficient quantity, of good quality or more or less impregnated with iron or other minerals. The sinking of test wells in several counties by State authority after a careful surface survey would surely pay. Owing to the fact that the surface west of the Dacotah is more elevated than in its own region of exposure, these wells could not be flowing wells—though the water might be expected to rise in the tube—unless, as sometimes might be the case, cracks and fissures in upper cretaceous strata gave local supply from the west. In the west of Mitchell county there is a true flowing well in an outlier of the Dacotah, though the source of supply is probably partly in the surface deposits—tertiary or alluvium. We refer to the famous Great Spirit Spring near Cawker City, the geology of which, we believe, has not before been described. It is a natural artesian well in the Dacotah.

CONCLUSION.

Dr. Peale and others of the National Geological Survey describe the development of the Dacotah, in the mountains of the west, as being in places metamorphosed by igneous action and elsewhere flexed and folded by tremendous forces. None of this appears in Kansas, but the relation of this formation to the Benton above and the Permian below is very like its position as described by Hayden and Lesquereux, in Nebraska. Before writing this paper we consulted such descriptive works as were within our reach, and while regretting that we could not obtain Hayden's Report for 1867, yet we were forci-

bly struck with the fullness and accuracy of the description given by Prof. Lesquereux in 1874, in his volume on the "Cretaceous Flora." Further, the more we look at the work done by our late esteemed friend Professor Mudge, the more we are impressed with the carefulness of his observations and the general justness of his conclusions. Hugh Miller tells us that wherever he followed in the track of Sir Roderick Murchison, he found all that geologist's work exact—the outline correct; only details to be filled in. We believe it is so with Professor Mudge. What he did, *was* done, and can be taken as a starting point for succeeding geologists.

We have given some description, we have indicated some problems, but we cannot now stay longer IN THE DACOTAH, except to say that our description falls much below the beauty and the wildness of this region; and that the solution of these problems will add much, not only to our stock of knowledge, but also to the material wealth of this, the Central State.

NOTES ON THE GEOLOGY OF THE SPANISH PEAKS.

BY J. SAVAGE.

Like most volcanic mountains, the Spanish Peaks stand isolated and alone. They are twins, and are known as the east or west peaks. When seen from a distance, their outlines stand out sharp and pointed against the sky. The east peak is entirely volcanic and destitute of mineral veins, and is the smaller of the two.

The west peak has a volcanic nucleus, or cone, but has a thick outer covering or mantle of the later sedimentary rocks. This outer blanket of soft sandstone has, by the intense heat of the inner volcanic material, been metamorphosed into hard, silicious quartzite, in which are found many metallic veins of the precious metals, besides abundance of lead and traces of copper.

Cotemporaneous with the elevation of the Spanish Peaks, and radiating from them like the spokes from a gigantic wheel, are found a remarkable system of dykes. These dykes are composed of varying volcanic material, and stretch off into the surrounding country from ten to twenty miles in extent. They were thrust up through the soft, friable sandstones of the Colorado lignite, in a soft, doughy state, leaving the impress of the sandstone mould all along their entire length. Near the peaks, where the power of erosion is much greater than elsewhere, the sandstone mould has been worn away, leaving the harder and more silicious dykes still standing as plumb and straight as a masoned wall, from 200 to 250 feet high; while further out in the surrounding plains, they have weathered down into sharp, steep knobs and peaks, thus presenting a picturesque and varied outline to the surrounding scenery.

Fisher's Peak, near Trinidad, is a notable example of one of these dyke remains.

The dykes, as they enter the west peak, are said by the miners to be converted into true fissure veins, and from what I could learn during a short climb up the mountain, I should judge their conjecture to be true. These mineral veins seem to penetrate the entire mountain, and divide it up into regular sections.

Near the base of the mountain, one dyke often cuts another in two, showing the one thus cut to be the older, but still soft and plastic when the newer one divided it in twain.

In approaching the peaks we find the strata gently dipping toward them, as though the giving out from beneath of so much volcanic material as composes the peaks and the dykes had left an empty space below, now occupied by the depressed strata.

I know of no richer field for exploration by young geological students, in all the Rocky Mountain region, than these Spanish Peaks, and the lessons learned from their study may be summed up as follows:

1st. All sharp-pointed mountain-peaks, whether seen from near or from far (and we

might as well include the mountains in the moon — for there is no one to dispute it) are composed of hard, silicious rocks. Notably are volcanic mountains included in this category: for example, the Sierra Nevadas, and the volcanic mountains of the Pacific coast, as well as those of Europe and Asia. Another inference I would like to make in this connection is this: that all mountain-peaks as seen to-day, are but fragmentary remains of what were once vast elevated plateaus, or long, massive elevated ridges, worn away by the tooth of time, and the present peaks are only the survival of the hardest, while the softer parts it may be have long since disappeared in the bottom of the ocean.

2d. The mission of the dykes, thrust up as they are through the vast seams of lignite coal — and many of these dykes have, no doubt, never reached the surface — is to mineralize the coal, or make it ready for the coke oven and furnace, as well as the coal grate, in the habitation of man: for example, the coal mines of Trinidad and vicinity, as well as those immense seams of coal near Walsenberg, on the way to Veta Pass. Otherwise these coal seams would have been only black carbonaceous dust, like the coal now quarried in our Dacotah in Russell county, along the Republican river, and also in many coal seams east of the mountains in Colorado.

3d. The lesson of metamorphism, which is a very important one to the geologist. This is seen illustrated upon the west peak, where its entire surface of soft sandstone is changed to hard quartzite; and still further it is seen all along the line of the dykes, which came up hot and changed the adjoining sandstone into quartzite for a few feet only, when it fades out into its original softness, and is thus weathered into steep cliffs all along the dykes, peaks which now dot all the surrounding country.

NOTES ON SOME KANSAS MINERAL WATERS.

BY PROFESSOR G. H. FAILYER, STATE AGRICULTURAL COLLEGE.

Some years since, a farmer living in the eastern part of Riley county, this State, in prospecting for coal, drilled to a depth of 120 feet; then abandoned this boring and began another one something over 100 yards distant from the first. In the meantime the water had risen to within four feet of the surface. A four-feet ditch was dug; from this the water flows at a rate which the farmer estimates, by measuring the flow during a short period, at 800 gallons per hour. At the depth of 85 feet the second well began to flow from the top, giving a stream, I am informed, 1¼ inches in diameter. The boring was continued to a depth of 180 feet. The water ceased to flow from the well, but a ditch two or three feet deep permitted the water to escape again. The capacity of the well is now 200 gallons per hour. Analysis of the waters of these wells gave the following results:

No. 1.	*Grams per litre.*	*Grains per U. S. gallon.*
Calc. oxide (as bicarb.*),	.090295	5.2766
Calc. oxide (not carb.),	.553883	32.3673
Mag. oxide,	.096792	5.6561
Iron oxide (as bicarb.),	.004101	.2426
Sodium,	.008699	.5183
Sulphuric acid (SO_3),	1.050101	61.3651
Chlorine,	.025060	1.4644
Silica,	.172785	10.0968
No. 2.		
Calc. oxide (as bicarb.*),	.103945	6.0746
Calc. oxide (not carb.),	.251383	14.6900

* Combined and free carbonic acid not determined.

Mag. oxide,	.112643	6.5824
Iron oxide (as bicarb.),	.005464	.3192
Sodium,	.014798	.8648
Potassium,	Trace	Trace
Lithium,	Trace	Trace
Sulphuric acid (SO_3),	.566664	33.1141
Chlorine,	.030788	1.7993
Silica,	.020285	1.1851

The water from a well drilled last spring in the southeastern part of Davis county was recently analyzed in our laboratory with the following result:

	Grams per litre.	*Grains per gal.*
Calcium oxide (as bicarb.),	.1328	7.7605
Magnesium oxide (as bicarb.),	.00764	.4465
Calcium oxide (not carb.),	.14843	8.6739
Magnesium oxide (not carb.),	.16634	9.7205
Lithium,	Trace	Trace
Sodium,	.05317	3.1017
Ferrous oxide (as bicarb.),	.00333	.1946
Alumina,	.02410	1.4083
Hydrogen sulphide (free),	.03375	1.9620
Hydrogen sulphide (combined),	.00850	.4967
Sulphuric acid (SO_3),	.64117	37.4683
Chlorine,	.01377	.8047
Phosphoric acid,	Trace	Trace
Iodine,	Trace	Trace
Boric acid,	Trace	Trace
Carbonic acid (combined),	.01884	6.5886
Silica,	.01502	.8774

Free carbonic acid not determined.

The well is 80 feet deep. The owner of the well states, that at a depth of about 60 feet a blowing noise was heard in the well, as though a cavity containing compressed gas had been tapped. He does not remember to have observed the odor of hydrogen sulphide at this time. The noise may have been due to the escape of this gas, but it does not seem probable.

In giving the analytical results, I have preferred to give the substances found, without combining them. Except in those cases where the compound may be precipitated by boiling, as in the case of the carbonates, only a shrewd guess can be made regarding the combination of the bases and the acids in such complex and dilute solutions.

[The following paper was received too late for a place upon the programme, but is here inserted as properly belonging to the proceedings of this meeting. It appears as received by Professor W. A. Kellerman, at whose request it was written.—SECRETARY.]

A CONTRIBUTION TO THE FLORA OF KANSAS—GRAMINEAL.

(With Plates I, II and III.)

BY F. LAMSON SCRIBNER.

TO PROF. W. A. KELLERMAN: I have examined the Kansas grasses contained in the package recently received from you, and I present herewith my determinations of the species. They are for the most part widely distributed in this country, and all save two of the genera—Chloris and Munroa—are described in Gray's Manual. Nearly double the number of species of grasses here enumerated probably occur within the limits of your State. The list is arranged according to the classification in Bentham and Hooker's Genera Plantarum.

8 and 30. Paspalum setaceum, Mx., Fl. I. 43; Nutt. Fl. Ark. 145; Gray's Man. 645; No. 802 of E. Hall's Texan collection.

9. Panicum sanguinale, L., Gray's Man. 646. (Digitaria, Beauv.; Nuttall, Fl. Ark. 145.)

53. Panicum scoparium, Lam., Thurber in Bot. Cal. II, p. 259. (P. pauciflorum of Gray's Man., p. 648, and probably also of Elliott, Nutt. Fl. Ark. 144.)

22. Panicum virgatum, L., Nutt. Fl. Ark. 144; Gray's Man. 647.

52. Panicum laxiflorum, Lam., Chapm. So. Flor. Suppl., p. 667; (P. dichotomum, L. var. 2, Chapm. So. Flor. 576.)

16 and 51. Panicum Crus-galli, L. Gray's Man. 649; Nutt. l. c. 144. Two forms are represented—one nearly awnless, and one with long awns and very rough glumes; (var. hispidum, Gray.)

63. Setaria glauca, P. B., Gray, l. c. 650; Lesqx. Fl. Ark. 397.

15. Cenchrus tribuloides, L., Gray, l. c. 650; Nutt. l. c. 145.

14. Spartina cynosuroides, Willd., Gray's Man. 619.

2. Tripsacum dactyloides, Linn. f., Nutt. Fl. Ark. 144; Gray's Man. 650.

19. Leersia Virginica, Willd., Nutt. l. c. 153; Gray, l. c. 607.

11. Andropogon provincialis, Lam. Encycl. l. 376, 1783. (Andropogon furcatus. Muhl. in Willd. sp. 4, 919, 1797; Gram. 281, 1817; Lesqx. Fl. Ark. 398; Gray's Man, 652.) In a letter from Prof. E. Häckel, of St. Poelton, Austria, who is now engaged in preparing a monograph on the Andropogonæ, he says: "The Andropogon furcatus, Muhl., which grows sparingly in southern France, has an older synonym: A. provincialis, Lam., a fact which seems unknown to American botanists. I am not sure of their being fully identical, but there is certainly no specific difference between them."

10. Andropogon scoparius, Mx., Lesqx. Fl. Ark. 398; Gray's Man. 652.

20. Chrysopogon nutans, Benth. (Sorghum nutans, Gray's Man. 652, Andropogon nutans, L., Andropogon avenaceus, Mx.; Nutt. Fl. Ark. 152.)

39. Aristida oligantha, Mx., Nutt. Fl. Ark. 135; Gray's Man. 618.

58. Aristida fasciculata, Torr. Ann. Lyc. N. Y. 2, 154, (1826.) (A. Hookeri, Trin.) No. 652 Hall and Harbour; No. 672 Powell; No. 336 Scribner, Montana coll.; 563 Fendler. This grass has been referred to A. purpurea, Nutt., but if it really be of that species—which, from seeing the two growing in the field and from the examination of a large number of specimens, I greatly doubt—Torrey's name takes precedence, as it is the earlier.

29. Aristida purpurea, Nutt. Fl. Ark. 1834, p. 143. This differs but a little from the genuine form of A. purpurea, as represented by No. 563 Lindheimer, and No. 768 E. Hall's Texan coll. It is apparently identical with No. 978 Fendler, (Aristida longiseta, Steud.,) and No. 476 E. Palmer (1877). A. filipendula, Buckl., is a rather larger form, but equally slender—not rigid like A. fasciculata—with a more numerously-flowered panicle and shorter awns. In order to fix more clearly the characters of Nuttall's plant, I will quote his excellent description of the species from the Trans. Am. Philos. Soc., vol. 5, (N. S.,) 1837.

"Panicula erectiuscula gracili; cal. valvulis remotis aristulatis apice bifidis; aristis capillaribus longissimus; foliis brevibus scabris. *Hab.*— on the grassy plains of Red river in arid situations; flowering in May. *Obs.*—perennial; leaves narrow, short and scabrous, ligule pilose; culm about one foot high, panicle many-flowered, a little spreading, branches capillary; flowers commonly in pairs, (after the manner of the genus,) bluish purple; one valve of the calyx, nearly double the length of the other, both bifid at the summit and shortly awned, the longer valve exceeding the corolla; awns equal, capillary nearly three times the length of the corolla and scabrous, corolla minutely stipitate."

13 and 40. Muehlenbergia glomerata, Trin., Gray's Man. 613.

49. Muehlenbergia sylvatica, Torr. and Gray, var. gracilis, Scribn. (n. var.) Panicles slender, like those of M. diffusa. It resembles somewhat M. monticola, Buckl., but in that species the empty glumes are much shorter than the floret, while in this they nearly equal it (exclusive of the awn), as in M. sylvatica. (Topeka, E. A. Popenoe.)

17 and 41. Sporobolus cryptandrus, Gray's Man. 610. (Agrostis and Vilfa, Torr.) No. 349 of my Montana collection.

42 and 54. Agrostis alba, L., Gray's Man. 612. Agrostis alba, var. vulgaris, Thurber in Bot. Calif. II, 272. (A. vulgaris, With.)

50. Agrostis scabra, Willd., Gray's Man. 611.

62. Cinna arundinacea, L., Nutt. Fl. Ark., p. 143; Gray's Man. 613. The specimens are slender, and have almost the habit of C. pendula, Trin., but they are at once distinguished from that species by the unequal outer glumes.

25. Chloris verticillata, Nutt. Fl. Ark. 150, and Trans. Am. Philos. Soc. vol. 5 (N. S.) 143. "Spicis plurimis verticillatis, radiatis, filiformibus; calicibus acuminatis bifloris; flosculis longe aristatis; gluma exteriore subbarbata; caule compresso. *Hab.*—On the sandy banks of the Arkansas, near Fort Smith, rare. Flowering in June. *Obs.*—Perennial. Culm compressed, branched from the base about 12 inches high; leaves pale green, narrowish, and flat; sheaths carinately compressed; stipules obsolete, hairy; spikes mostly verticillated in two series, the first aggregation consisting of from 7–9 spikes; spikes filiform and stellately spreading, pilose at the base, about 6 inches long; flowers (*spikelets*) unilateral, alternating in two rows; calyx (*empty glumes*) acuminate, two-flowered, one of the flowers perfect, the other neuter, the dorsal valves (*flowering glumes or lower palets*) of both gibbous, obtuse and awned, the awn more than twice the length of the flower, that of the hemaphrodite bearded; seed triangular, smooth and even; anthers 3; stigmas 2, brown. There are few grasses in America more curious and elegant. Its aspect is that of a tropical species." (Nuttall.)

27. Schedonnardus Texanus, Steudel, Syn. Gram. 146, (1855.) Upham, Flora, Minn. 169. (Lepturus paniculatus, Nutt., Gen. l. 81, 1818. Flora Ark. 152; Gray's Man. 637.) This grass belongs to the tribe Chlorideæ, and is allied to Gymnopogon, while the true Lepturi, of which we have no North-American species, excepting the sparingly introduced L. incurvatus and L. filiformis, belong in Hordeæ, between Agropyrum and Hordeum. Lepturus Bolanderi, Thurber, described by Dr. A. Gray in Proc. Am. Acad. Arts and Sci., p. 401, 1867, and by Prof. Thurber in Bot. Calif. II, 322, (Bolander, No. 4669; collected also in California by E. L. Greene, and in southern Oregon by Howell,) cannot be referred to either of the genera here named as they are characterized, nor is it referable to any of the allied genera in either groups. I am of the opinion that it constitutes an independent genus.

26 and 38. Bouteloua oligostachya, Torr., Gray's Man. 621. (Atheropogon oligostachya, Nutt. Gen. l. 78, Fl. Ark. 150.)

37. Bouteloua hirsuta, Lag., Gray's Man. 621.

12. Bouteloua curtipendula, Torr. in Emory's Rept. 1848, p. 153. (Chloris curtipendula, Mx., Fl. l. 59, 1803, Bouteloua racemosa, Lagasca, Varied. de Cienc., 1805, No. 22, 141.) The specimens belong to the var. aristosa, Gray.

18. Triodia seslerioides, Bentham, (Poa seslerioides, Mx., Fl. l. 68, 1803. Tricuspis seslerioides, Torr.; Gray's Man. 624. Triodia cuprea, Jacq., Eclog. Gram. 2, 21, t. 16, 1815. Uralepsis cuprea, Kth. Gram. l. 108, 313, t. 68.)

28. Munroa squarrosa, Torr., Pacific R. R. Rep. IV, 158. (Crypsis squarrosa, Nutt., Gen. l. 49.) In 1883, I found this grass growing near Fort Benton, Montana, the most northern point yet reported for its distribution.

Kœleria cristata, Pers.; Gray's Man. 625. This is a very common grass in all the region west of the Mississippi and in Montana, where I have heard it called "June grass." It often covers the extensive bench-lands in equal abundance with its associate, *Poa tenuifolia*. The species, as we have it, presents a variety of forms, some of which may prove good species. Upon the dry bench-lands, where the grass stands thinly, the radical leaves or those of the sterile shoots are short (2–3 inches) and strongly involute. In

other localities the narrow, radical leaves nearly equal the culm in length. Sometimes the leaves are nearly smooth, and again they are strongly pilose; in some Oregon specimens the lower sheaths are hirsute. The panicle, usually short and dense, is sometimes elongated (6 inches or more), with erect or ascending lower branches 1–2 inches long. The spikelets are from 2–5 fld., and vary in size from 1½–1 inches to 3–1 inches in length, with a proportional variation in width. The glumes are thin and membraneous with broad scarious margins, nearly smooth and sharply acuminate or obtuse, strongly scabrous and firm in texture (sub-coriaceous). The outer or empty glumes are always unequal in size, and though generally of unequal length, they are sometimes equal or nearly so; usually shorter than the spikelet, they sometimes equal or even exceed it. In the typical plant the flowering glumes are very acute, often terminating in a short awn. In some of our forms, however, they are obtuse, while from California come samples in which the flowering glume is slightly notched at the tip, and the mid-nerve extends between the lobes as a short mucronate point. These Californian specimens also differ from all others examined in having the paleæ as long or even longer than their glumes*.

43. Eatonia Pennsylvanica, Gray's Man. 626. This and E. obtusata, Gray, which I also have from Kansas, vary a good deal in inflorescence and in the special characters of the spikelets, and intermediate forms occur making it difficult to distinguish the one from the other. In E. obtusata the spikelets are scarcely more than a line in length, florets very obtuse, and the second glume is broader than it is long, and saccate around the second floret. The panicle, usually erect and densely many-flowered, especially in western specimens, is sometimes nutant and loosely few-flowered. Specimens of this species are at hand from Massachusetts, New York, Pennsylvania, Illinois, Michigan, Belleville, (Canada,) Florida, Georgia, Louisiana, Texas, Kansas, Utah, Washington Territory, Arizona, and Montana.

E. Pennsylvanica is a taller and more robust species, with a larger and more open panicle, spikelets 2–3 in. long, florets longer and usually more pointed, sometimes even awned, while the second glume, although broad and obtuse, is not so broad in proportion to its length as in E. obtusata. It has about the same distribution.

Eragrostis major, Host. Gram. IV t. 24, 1809. Megastachya Eragrostis, Beauv. E. pœoides, var. megastachya, Gray. Beauvois was not the author of E. pœoides as quoted by authors. This name does not occur in Beauvois's work, nor is it applied to the figure illustrating this species; it only appears in the index, without reference to any page of the book, nor to any previously published species. Beauvois's work, here referred to, was published in 1812, and even had he given this name—E. pœoides—Host's name would take precedence, it being the earlier. E. minor Host—E. pœoides of authors, not of Beauvois.

21. Eragrostis pectinacea, Gray's Man. 632, Lesqx. Fl. Ark. 396.

34. Eragrostis reptans, Nees., Gray's Man. 631. (Poa reptans, Mich., Nutt. Fl. Ark. 146.)

*Nuttall, in the Herb. Acad. Nat. Sci. Phila., proposed several names for forms of this species. "K. glabrata," "K. Oregona" and "K. melanthera" are all K. cristata. "K. Arkansana" and "K. Montana" belong to K. nitida, Nutt. Gen. I 74. K. tuberosa, Nutt. Fl. Ark. 148; K. cristata, var. gracilis, Gray, a species which I think ought to be restored. It is distinguished from K. cristata by the smaller size of its spikelets, by its obtuse glumes, and especially by the much firmer (almost coriaceous) texture of its glumes. In the proposed variety of K. nitida—var. Arkansana—(K. Arkansana, Nutt. in herb.), the culms are stouter and more leafy; the leaves are flat and longer than in the species, the upper one 3–5 inches long; panicle elongated (3–6 inches), the erect or slightly spreading lower branches 1–2 inches long. Spikelets 3–4 fld., in texture resembling those of K. nitida; quite unlike those of K. cristata. 6. K. nitida Nutt. I 74. 48. K. nitida. (K. tuberosa Nutt. Fl. Ark. 148.) 47. K. nitida var. Arkansana. (K. Arkansana, Nutt. in herb.)

55. Eragrostis tenuis, Gray's Man., 2d ed. 564, and 5th ed. 632. (Poa trichodes, Nutt. Fl. Ark. 146.)

36. Melica mutica, Walt., var. diffusa, Gray's Man. 626. (M. diffusa, Pursh., M. glabra, Mx., Nutt. Fl. Ark. 148.)

59. Uniola latifolia, Mich., Nutt. Fl. Ark. 148, Gray's Man. 636. Distichlis maritima, Raf. var., strictum, Thurb. Bot. Calif., II 306. (Uniola stricta, Torr., Uniola multiflora, Nutt. Fl. Ark. 148. Brizopyrum spicatum, var. strictum, Gray.)

35, 36*a*, 44. Poa flexuosa, Muhl., Gray's Man. 630.

45. Poa compressa, L., Gray's Man. 629.

61. Festuca elatior, L., Gray, l. c. 634.

7. Festuca tenella, Willd., Gray, l. c. 633, Nutt. Fl. Ark. 141 (sub-var. glauca.)

5, 32, 33. Bromus; the specimens are all probably B. ciliatus, L. They differ somewhat from the more eastern plant, but I am unable to separate them. Our North-American Bromi are as yet very imperfectly identified.

31. Agropyrum glaucum, R. & S., var. occidentale. Glumes narrower and more acute than in the European plant. This has been referred to Triticum repens, L., by most American authors, but it is abundantly distinct.

56. Hordeum pusillum, Nutt., Gen. I 87, Fl. Ark. 151. This species has been united with H. nodosum, L., (H. pratense, Huds.,) by recent American authors, but it is well characterized by its broad outer glumes, as well as by its usually lower and more rigid habit of growth.

23, 24. Elymus Canadensis, L. Gray's Man. 639, Nutt. Fl. Ark. 151.

EXPLANATION OF PLATES.

PLATE I.—*Chloris verticillata.*

Fig. 1. Habit of the species, reduced.
Fig. 2. Spikelet, much enlarged.
Fig. 3. Same with the two lower glumes removed.
Fig. 4. The stipitate imperfect floret.

PLATE II.—*Munroa squarrosa.*

Fig. 1. Habit of plant.
Fig. 2. Cluster of leaves terminating a branch and inclosing the inflorescence, enlarged (original).
Fig. 3. Spikelet, much enlarged.
Fig. 4, 5. The lower glumes.
Fig. 6. Flowering glume.
Fig. 7. Palea.
Fig. 8. Pistil. 9. Seed.

PLATE III.—*On Kœleria and Eatonia.*

Fig. 1. Spikelet of Kœleria cristata, from European specimen.
Fig. 2. " " " cristata, from Montana.
Fig. 3. " " " from specimen in Herb. Acad. Nat. Sci., Phila., ticketed by Nuttall "*K. Arkansana.*"
Fig. 4. Spikelet of Kœleria, from specimen coll. by Bigelow, probably in New Mexico.
Fig. 5. " " " nitida, Nutt.— from Kansas.
Fig. 6. " " " from Californian specimen collected by Miss Scott.
Fig. 7. Eatonia.—Spikelets three-fold.
Fig. 8. Eatonia.—Panicle nutant, open and loosely few-flowered. A well-marked form with unusually large and three-fold spikelets.
Fig. 9. Eatonia.—Paleæ remarkably long, equaling or exceeding their glumes.
Fig. 10. Eatonia.—Paleæ much shorter than their glumes.
Fig. 11. Eatonia Pennsylvanica, from specimen supposed by Dr. Vasey to be a hybrid between E. Pennsylvanica and Trisetum palustre.
Fig. 12. Eatonia Pennsylvanica—from Louisiana.
Fig. 13. Eatonia Pennsylvanica—from Kansas.
Fig. 14. Eatonia obtusata—with unusually long and large lower glume.
Fig. 15. Eatonia obtusata—from Kansas, genuine form.

(These figures are all enlarged to the same scale.)

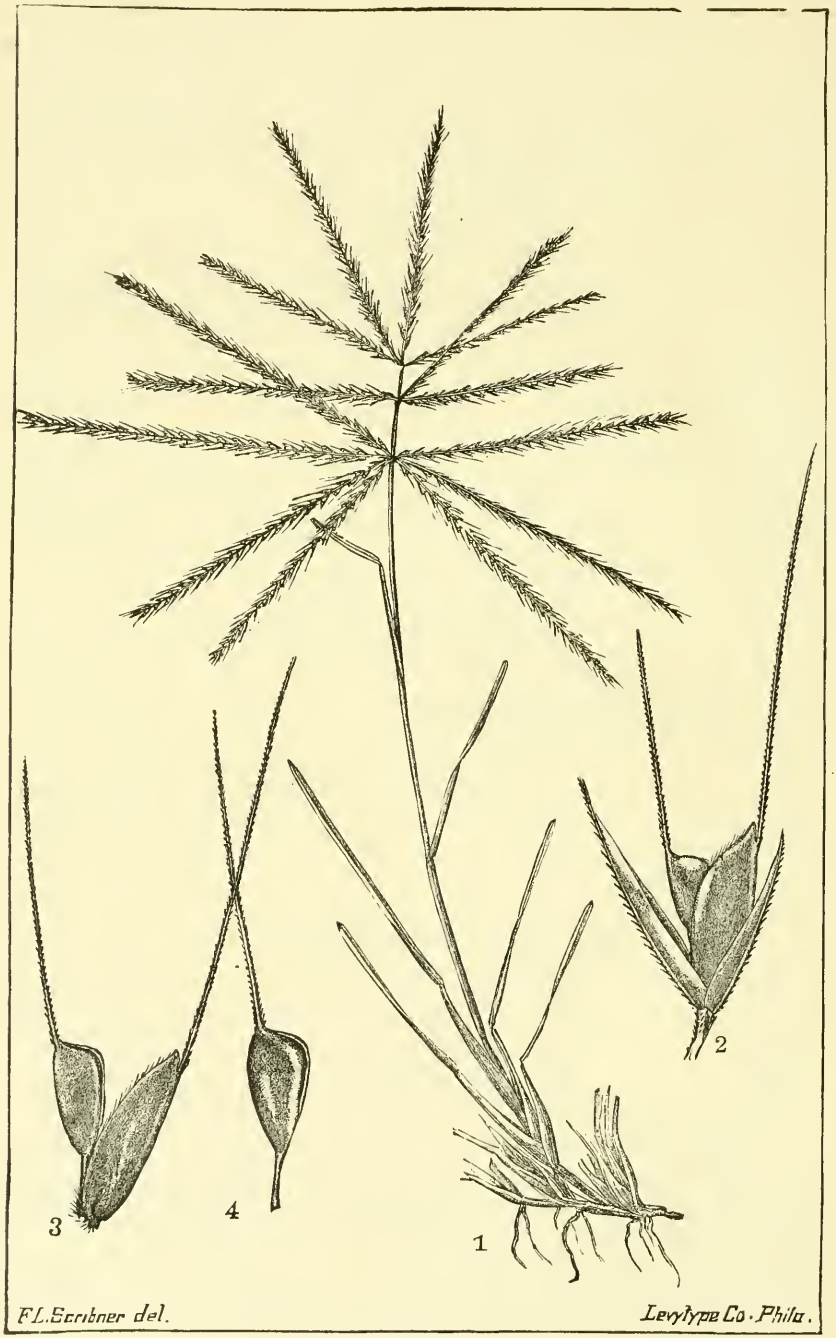


PLATE I.

PLATE II.

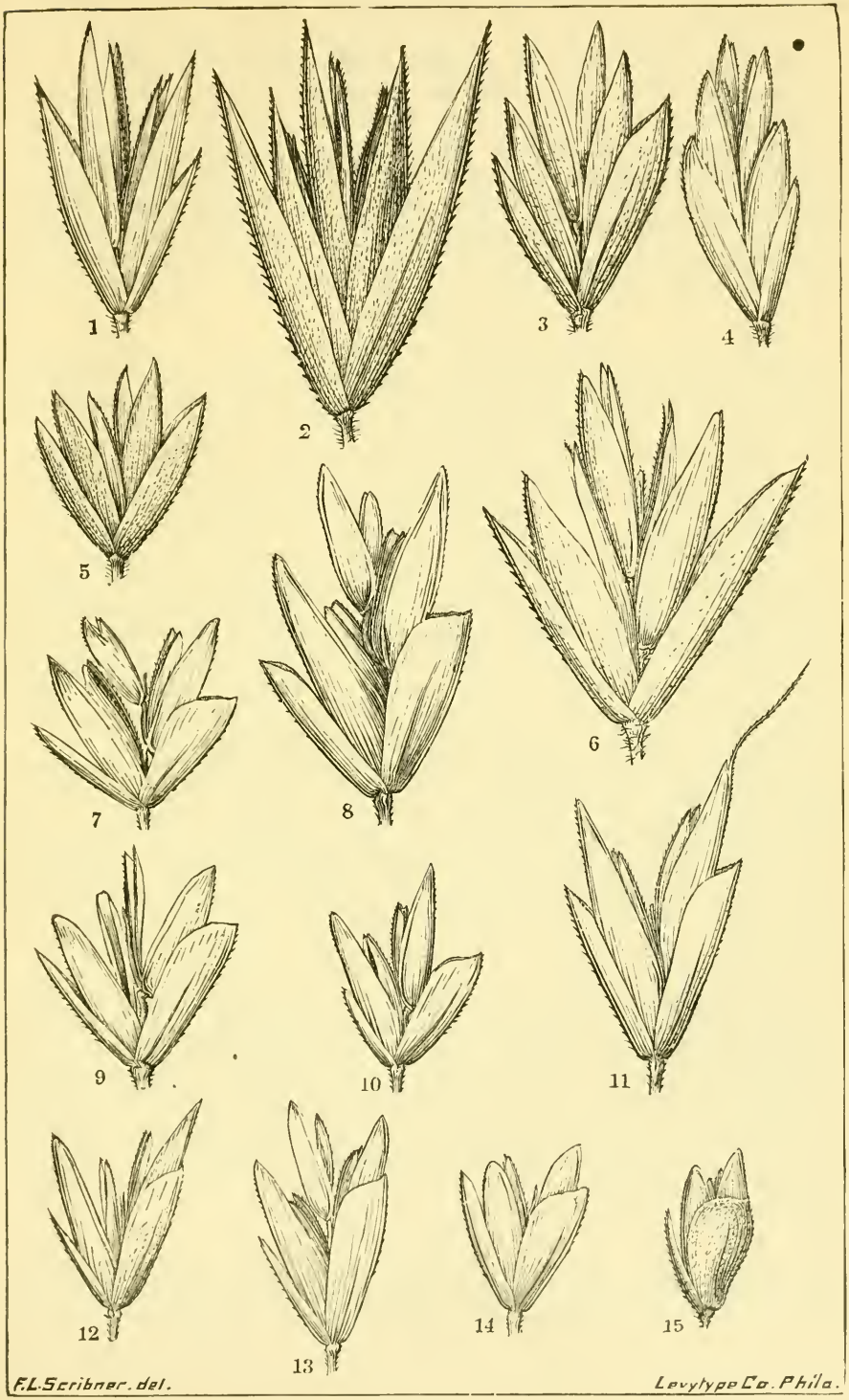


PLATE III.

METEOROLOGICAL SUMMARY FOR THE YEAR 1884.

PREPARED BY PROF. F. H. SNOW, OF THE UNIVERSITY OF KANSAS, FROM OBSERVATIONS TAKEN AT LAWRENCE.

The most notable features of the year 1884 were the low mean temperatures of the spring, summer and winter months; the high mean temperature of the autumn months; the very large rainfall, which came within half an inch of the extraordinary precipitation of the year 1876; the unusual percentage of cloudiness; the low velocity of the wind; the decided preponderance of south winds over north winds; and the increased percentage of atmospheric humidity.

TEMPERATURE.

Mean temperature of the year, 51.30°, which is 2.11° below the mean of the sixteen preceding years. The highest temperature was 98°, on July 8th; the lowest was 21.5° below zero, on the 5th of January, giving a range for the year of 119.5°. Mean at 7 A. M., 45.69°; at 2 P. M., 59.40°; at 9 P. M., 50.04°.

Mean temperature of the winter months, 24.19°, which is 5.71° below the average winter temperature; of the spring, 51.41°, which is 2.41°, below the average; of the summer, 73.05°, which is 3.05° below the average; of the autumn, 56.59°, which is 3.01° above the average.

The coldest month of the year was January, with mean temperature 20.99°; the coldest week was January 1st to 7th, mean temperature, .07° below zero; the coldest day was January 5th, mean temperature, 12° below zero. The mercury fell below zero fourteen times, of which seven were in January, one in February, and six in December.

The warmest month was July, with mean temperature 76.93°; the warmest week was July 20th to 26th, mean 79.66°; the warmest day was July 8th, mean 86.87°. The mercury reached or exceeded 90° on 20 days, (one less than half the average number,) viz.: two in June, ten in July, three in August, and five in September.

The last hoar frost of spring was on April 24th; the first hoar frost of autumn was on October 8th; giving an interval of 167 days, or nearly six months, entirely without frost. The average interval is 154 days.

The last severe frost of spring was on April 8th; the first severe frost of autumn was on the 23d of October; giving an interval of 198 days, or nearly seven months, without severe frost. The average interval is 199 days. No frost during the year caused damage to crops of grain and fruit. The low temperatures of January were generally destructive to peach buds.

RAIN.

The entire rainfall, including melted snow, was 43.70 inches, which has been but once exceeded on our 17 years' record (in 1876), and is 9.05 inches above the annual average. Either rain or snow, or both, in measurable quantities, fell on 115 days—11 more than the average. On nine other days rain or snow fell in quantity too small for measurement.

There was no approach to a drouth during the year, the longest interval without rain in the growing season being 13 days, from July 30th to August 12th.

The number of thunder showers was 35. There was but one light hail storm during the year—on May 17th.

SNOW.

The entire depth of snow was 29 inches, which is 8.62 inches above the average. Of this amount, 12 inches fell in January, 2 inches in February, 1 inch in March, 6 inches in April, 1½ inches in November, and 6½ inches in December. Snow fell on 21 days.

The last snow of spring was on April 21st. The first snow of autumn was on November 18th—10 days later than the average date.

FACE OF THE SKY.

The mean cloudiness of the year was 47.56 per cent., which is 3.09 per cent. above the average. The number of clear days (less than one-third cloudy) was 146; half clear (from one to two-thirds cloudy), 116; cloudy (more than two-thirds), 104. There were 75 days on which the cloudiness reached or exceeded 80 per cent. There were 33 entirely clear and 43 entirely cloudy days. The clearest month was October, with a mean of 34.19 per cent.; the cloudiest month was December, mean 66.34 per cent. The percentage of cloudiness at 7 A. M. was 53.89; at 2 P. M., 49.76; at 9 P. M., 39.03.

DIRECTION OF THE WIND.

During the year, three observations daily, the wind was from the S. W. 266 times, N. W. 252 times, S. E. 201 times, N. E. 197 times, S. 76 times, N. 46 times, E. 37 times, W. 23 times. The south winds (including southwest, south and southeast) outnumbered the north (including northwest, north and northeast) in the ratio of 543 to 495.

VELOCITY OF THE WIND.

The number of miles traveled by the wind during the year was 131,188, which is 7,421 miles below the annual average for the eleven preceding years. This gives a mean daily velocity of 358.44 miles, and a mean hourly velocity of 14.93 miles. The highest hourly velocity was 75 miles, on June 25th; the highest daily velocity was 990 miles, on the 19th of January; the highest monthly velocity was 14,368 miles, in January. The three windiest months were January, March and April; the three calmest months were June, July, and August. The average velocity at 7 A. M. was 14.62 miles; at 2 P. M., 16.91 miles; at 9 P. M., 14.27 miles.

BAROMETER.

Mean height of barometer column, 29.111 inches, which is .006 inch above the annual mean. Mean at 7 A. M., 29.133 inches; at 2 P. M., 29.091 inches; at 9 P. M., 29.109 inches; maximum, 29.881 inches, on January 4th; minimum, 28.451 inches, on March 27th; yearly range, 1,430 inches. The highest monthly mean was 29.333 inches, in February; the lowest was 29.002 inches, in April. The barometer observations are corrected for temperature and instrumental error only.

RELATIVE HUMIDITY.

The average atmospheric humidity for the year was 72.6; at 7 A. M., 83.1; at 2 P. M., 55.8; at 9 P. M., 78.8. The dampest month was September, with mean humidity, 77.8; the driest month was March, mean humidity, 65.0. There were 28 fogs during the year. The lowest humidity for any single observation was 15 per cent., on March 12th.

The following tables give the mean temperature, the extremes of temperature, the number of inches of rain and snow, the number of rainy days, the number of thunder showers, the mean cloudiness, the relative humidity, the number of fogs, the velocity of the wind, the mean and extreme barometer heights, for each month of the year 1884, and a comparison with each of the sixteen preceding years.

YEAR 1884.

1884.	Mean temperature.	Max. temperature.	Min. temperature.	Rain, inches.....	Snow, inches	Rainy days	Thunder storms...	Mean cloudiness...	Mean humidity....	No. of fogs	Miles of wind.....	Mean barometer...	Max. barometer....	Min. barometer....
January ...	20.99	57.0	-21.5	1.28	12.0	7	0	41.42	73.9	3	14,368	29.313	29.881	28.735
February ..	28.03	57.0	- 1.0	1.13	2.0	8	1	54.33	72.3	1	11,651	29.158	29.469	28.587
March	41.56	73.0	12.0	2.73	1.0	9	5	58.87	65.0	2	14,229	29.054	29.465	28.451
April	50.42	76.5	28.5	5.62	6.0	13	4	55.76	65.9	1	13,954	29.001	29.321	28.495
May.....	62.24	85.0	36.0	3.57	0.0	12	2	50.54	68.9	2	9,978	29.046	29.299	28.689
June.....	71.07	92.0	48.0	3.81	0.0	12	7	38.78	71.8	1	6,806	29.065	29.270	28.831
July	76.93	98.0	60.5	5.18	0.0	15	5	41.67	71.7	1	8,733	29.004	29.289	29.809
August.....	71.14	92.5	47.5	5.49	0.0	11	4	48.16	77.8	3	9,392	29.110	29.405	28.849
September,	70.36	92.0	48.0	9.15	0.0	8	5	40.00	76.3	3	11,409	29.037	29.404	28.810
October.....	57.87	85.0	31.0	2.38	0.0	8	2	34.19	74.8	5	10,150	29.179	29.568	28.712
November,	41.53	70.0	9.5	0.80	1.5	3	0	40.77	72.0	5	10,503	29.175	29.563	29.634
December..	23.54	59.5	6.5	2.56	6.5	9	0	66.34	80.0	1	10,015	29.189	29.666	28.618
Mean...	51.30	78.1	25.4	3.64	2.4	10	3	47.56	72.6	2	10,932	29.111	29.467	28.685

SEVENTEEN YEARS: 1868–1884.

Years.	Mean temperature.	Max. temperature.	Min. temperature.	Hot days (above 90 degrees).....	Zero days.....	Days between severe frosts.....	Rain, inches.....	Snow, inches.....	Rainy days.....	Thunder storms...	Mean cloudiness...	Mean humidity....	No. of fogs.....	Miles of wind.....	Mean barometer...
1868...	53.36	101.0	-16.5	43	7	160	37.48	27.50	77	....	42.35	.....	....	.....	.....
1869...	50.99	96.0	- 5.0	23	2	167	38.51	18.00	105	33	49.23	78.2	19	.....	29.103
1870...	54.50	102.0	-10.0	51	6	197	31.32	9.50	100	27	47.88	68.4	13	.....	29.097
1871...	54.30	103.0	- 6.0	48	8	218	33.23	29.75	120	24	47.37	65.9	6	.....	29.076
1872...	51.90	97.0	-18.0	45	16	192	32.63	23.25	116	40	44.33	64.4	11	.....	29.112
1873...	52.71	104.0	-26.0	48	9	165	32.94	26.50	101	17	42.46	64.0	6	154,508	29.093
1874...	54.20	108.0	- 3.0	58	2	187	28.87	43.00	99	20	45.54	65.7	14	145,865	29.121
1875...	50.60	99.0	-16.5	32	12	196	28.87	5.00	106	21	44.81	66.7	5	145,316	29.102
1876...	52.76	98.0	- 5.0	36	4	179	44.18	25.75	102	29	41.27	66.8	4	148,120	29.102
1877...	54.16	99.0	- 9.0	20	3	217	41.09	15.50	126	39	47.12	72.6	11	113,997	29.117
1878...	55.33	98.0	- 6.0	35	7	228	38.39	25.50	107	38	40.65	70.2	5	125,793	29.067
1879...	54.67	99.5	-16.0	48	13	203	32.68	10.35	90	36	40.01	67.1	10	124,758	29.127
1880...	54.01	101.0	-12.0	41	2	211	32.65	7.00	89	29	40.15	67.9	18	146,039	29.123
1881...	54.65	104.0	- 8.0	68	6	210	33.27	32.50	110	31	47.42	70.1	11	141,430	29.103
1882...	54.94	105.0	- 6.5	40	1	232	27.60	18.00	102	26	45.41	68.6	14	137,736	29.113
1883...	51.66	96.5	-14.0	26	8	217	40.65	12.50	106	32	45.24	69.7	18	141,164	29.135
1884...	51.30	98.0	-21.5	20	14	198	43.70	29.00	115	35	47.56	72.6	28	131,188	29.111
Mean,	53.29	97.8	-12.8	41	7	199	35.18	20.87	104	30	44.65	68.7	12	137,591	29.106

APPENDIX.

APPENDIX.

[The following articles, read at the meeting in 1883, were received (April, 1885,) too late for insertion in their proper places, and are given here.—SECRETARY.]

THE AGE OF KANSAS.

BY B. B. SMYTH, TOPEKA.

(Read before the Academy of Science, at Topeka, November, 1883.)

The altitude of the State of Kansas varies from 750 feet above the level of the sea at the mouth of the Kaw, to about 4,000 feet near the northwest corner. The west line of the State averages about 3,000 feet higher than the east line, thus giving an average slope from west to east of about 7½ feet to the mile. The slope or fall in the western part of the State is greater than in the eastern part. The average fall, however, of the Kaw and Arkansas rivers, except in the western part of the State, is somewhat less than 7½ feet to the mile, owing to their devious courses.

ROCKS.

The rock system of Kansas is exceedingly simple, commencing in the southeast corner with the sub-carboniferous, and ending in the northwest corner with the pliocene tertiary. Over almost the entire State the rocks are monoclinal and dip gently to the northwest at an average rate, in the central part of the State, at least double the average slope of surface to the southeast; though further west there is scarcely any perceptible dip in most places, and in others slightly to the northeast. And so far as I am aware, west of Topeka there is not a fault, fissure, fold or displacement of any consequence*. Evidences of non-conformability are only very slight†. These things, however imperfectly known at present, will be better known after there has been a systematic geological survey of the State.

With the successive strata thus lying in natural and undisturbed positions, the calculation of a problem of time becomes a comparatively simple one, depending, for its accuracy, upon the care taken in the investigation, or the proper observance of the data at hand.

CALCULATION.

Whether the strata of rock were as thick at the Missouri State line as at their present outcrop in Kansas, I have no means of judging; but, in the absence of any opposing testimony, we may assume that they were the same. Adopting the estimates of St. John as most trustworthy, I find that the thickness of the outcrop from northwest corner to southeast corner is over 6,000 feet, from which the average outcrop from the west line to the east line may be figured at 5,000 feet.

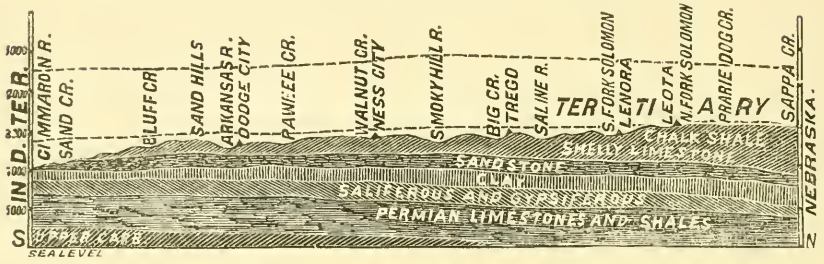
Now, considering that superposed strata to the amount of say 300 feet have been washed away at the northwest corner, this would make an average of 670 feet washed away along the west line of the State and 5,670 feet along the east line, thus making an average of 3,170 feet, or fully three-fifths of a mile in thickness over the entire State, equal to, since the State is 396 by 208 miles in area, a total of 50,000 cubic miles of earth

*Mudge, 1st Bien. Rep. Kan. St. Bd. Agr.

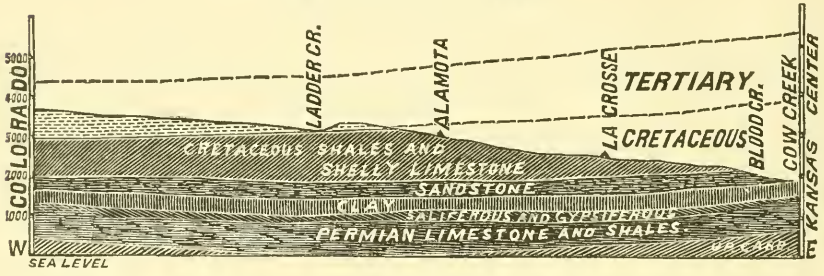
†Hay, present meeting, and St. John, 3d Bien. Rep. K. S. B. Agr.

VERTICAL SECTIONS THROUGH KANSAS.

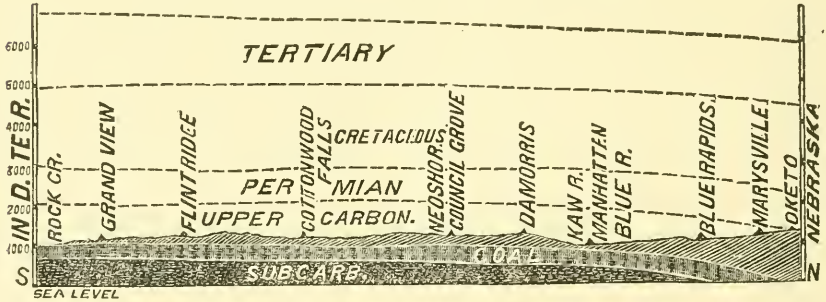
(Horizontal scale, 50 miles to the inch. Vertical scale, 5,000 feet to the inch.)



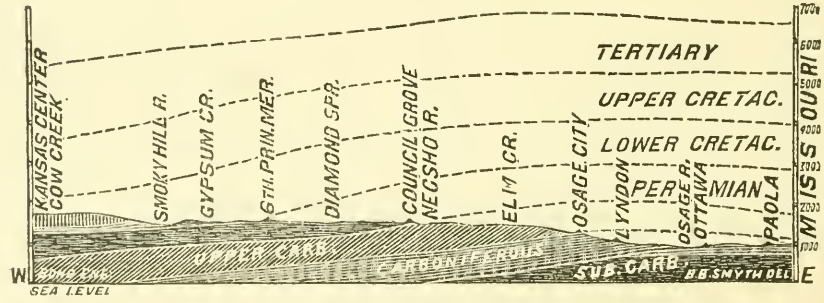
Section along 100th meridian.



Section along parallel of 38° 30′ (western half of State.)



Section along meridian of 96° 40′.



Section along parallel of 38° 30′ (eastern half.)

and disintegrated rock washed entirely away and carried to the ocean, or more properly, perhaps, the Gulf of Mexico. As a matter of fact, it was much more than that; for, where evidences of non-conformability appear between strata, it shows that there the surface at one time underwent a period of denudation and subsequent subsidence and immersion and consequent accumulation by deposition.

But, not counting what we do not see, what must have been the length of time required to remove the 50,000 cubic miles we do see, and carry the material utterly away?

Time is long. The existence of man is but a mere speck of time during this measurable portion of eternity.

SPECULATION.

If we may judge of the past by the present, the time occupied in the removal of the rock strata showing at the surface within the State of Kansas may be computed. No part of the surface of the State comprises any portion of the igneous rocks formed during the immeasurable past.* There are no outcropping rocks but those formed by sedimentary deposition.

No attempt, however, will be made in this paper to show the length of time elapsed during deposition. Arguments will be confined strictly to the time elapsed during degradation, whether continuous or interrupted.

In this article no presumption is made at accuracy of statement. No necessity exists for it. Figures will be given only in general terms and approximately. When it is remembered that an error in observation of even an inch in the depth of a river or the thousandth part of an inch in the depth of sediment deposited in a vessel of water, or of a week in the length of time a river should run during a year, might lead to an error of a million years, more or less, it will be observed how utterly futile an attempt at accuracy in these matters may be.

DEGRADATION.

The principal agents of degradation are water and air in motion. These will be considered in turn:

I.—*The Agency of Water.*

The rivers of the State carry off constantly earth in two forms — in suspension and in solution. Degradation by water, in Kansas, progresses mainly by two methods: 1st, by *denudation*, or washing of the surface; 2d, by *percolation*, or seeping—drawing out through springs, subterranean veins, etc. Both of these methods carry earth in the two forms named. The first carries mud and light earths in suspension and organic substances in solution; the second carries mainly sand in suspension and various alkaline salts and mineral matters in solution. The tendency or inclination, then, of surface water is acid, of spring water is alkaline.

The percentage of mud carried by a stream is greatest in a freshet; the percentage of sand carried is nearly always the same in the same stream; and the percentage of mineral matters held in solution is always greatest in low water, and the amount nearly always the same in a given river, whether the water is high or low.

A third method of degradation, namely *corrasion*, or the wearing away of the bed of a stream more rapidly than the surface of its basin, is still taking place to a small degree in the headwaters of the Kaw tributaries; in the bed of the Kaw itself very little; and in the Arkansas not at all.

The upper tributaries of the Kaw receive their load of earthy matters mainly by washing; the Kaw proper, Neosho and Osage partly by washing and partly by seeping; the Arkansas almost entirely by seeping.

The Arkansas bears evidence of being an older and maturer stream than the Kaw—perhaps because its bed is filled every summer with water from the mountains; perhaps

* Haworth, 8th Bien. Rep. Kan. Acad. Sci.

because during each Platonic winter there may be many summer seasons when the Kaw is bound in ice that the Arkansas is free to run.

The greatest future change of surface will take place along the headwaters of the Kaw, where erosion is at present most brisk; the least future change will take place in the valley of the Arkansas, where erosion at present is but slight.

The earth that is carried down by the Kaw finds its way into the river mostly by the action of water. On the other hand, the earth that is carried down by the Arkansas from the surface of Kansas is carried into the river mostly by the wind. The clayey and alkaline portions are carried away quite readily; the sand goes out slowly. In winter, when north winds prevail, the Arkansas is dry, and the wind blows considerable sand out of the bed of the river, and makes ranges of sand-hills all along south of the river. In summer, when the prevailing winds are south, the river is filled with water and no sand is blown out. From Hutchinson to Arkansas City, over which course the river runs nearly south and is seldom dry, there are no sand-hills.

AREA.

The area drained by the Arkansas is 22,000 square miles in Kansas, and 26,000 in Colorado—48,000 square miles in all. This does not include the territory drained by the Cimarron, etc. The area drained by the Kaw is 63,000 square miles, of which 36,000 square miles are in Kansas, 18,000 square miles in Nebraska, and 9,000 square miles in Colorado. The area drained by all other rivers is 24,000 square miles, all of which rivers have their headwaters within the State, except the Missouri and the Cimarron, neither of which need be considered except as on the borders of the State.

RAINFALL.

The rainfall of the basin drained by the Arkansas averages a depth of $22\frac{1}{2}$ inches per annum, being 24 inches within the State, and 21 inches in Colorado. The rainfall of the Kaw basin averages 26 inches per year in Kansas, 23 inches in Nebraska, and 18 inches in Colorado—24 inches for the entire basin. The rainfall of all other sections averages 30 inches per annum.

PRECIPITATION.

This would show that the average rainfall of the entire Arkansas basin, as far down as Arkansas City, Kas., is 2,450 billion cubic feet per annum, of which 1,269 billions fall in Colorado. The rainfall of the entire Kaw basin is 3,515 billion cubic feet, of which amount 1,340 billions fall in Nebraska and Colorado. The rainfall of all other streams is figured at 1,673 billion cubic feet, all of which is precipitated in the State. According to this, then, the total precipitation in Kansas amounts to 5,075 billion cubic feet in a year.

EVAPORATION.

Were evaporation and permeability of soil equal all over the State, discharge through the rivers would be in proportion to the rainfall. But it is well known that evaporation is greatest in the western part of the State, and permeability is greatest in the central part. From many experiments and constant observation made in Barton county, from 1874 to 1880, I determine that, though in many years, from Ellinwood west to the Colorado line, evaporation is greater than the rainfall, yet ordinarily there is a small excess of rainfall. Evaporation in the Arkansas valley averages 95 per cent. in Kansas, and $94\frac{1}{3}$ per cent. in Colorado, averaging $94\frac{2}{3}$ for that basin. Evaporation is 94 per cent. in the Kaw basin in Kansas, and $94\frac{3}{4}$ in Nebraska and Colorado, thus averaging $94\frac{1}{4}$ for the whole basin. The evaporation in the valleys of the Neosho, Osage, and other streams, is estimated at 92 per cent., which may possibly be too low. I have no means of knowing the proportion of seepage separately. It is included in the above figures for evaporation.

DISCHARGE.

I have not seen the Arkansas where it leaves the State, but from my information and knowledge of the stream, I estimate an average width of 840 feet, a depth of 1¼ feet for ten months in the year, and a velocity of 3½ miles per hour. Adopting this estimate, we find that 133 billion cubic feet of water would be discharged from the State, on an average, in the course of a year. Of this amount, 72 billion cubic feet is carried into the State from Colorado, leaving 61 billions to be collected in the State. The Kaw is not quite so wide as the Arkansas, but is very much deeper, and flows with about the same velocity; and, unlike the Arkansas, the bed is not filled with quicksand. Besides, the Kaw is never dry, as is the Arkansas, but flows all the year round. Yet I have no reliable data as to its average width and depth at its mouth. But calculating from the annual precipitation and evaporation, I find that the Kaw should discharge 201 billion cubic feet in a year, of which 70 billions come down from Colorado and Nebraska, leaving 130 billions to be gathered from the State. Similar calculation makes all other streams carry off 134 billion cubic feet, entirely from Kansas.

LOAD.

The amount of earth carried by a stream is in proportion to the square of the pitch or slope of surface of the earth multiplied by the excess of rainfall over evaporation and seepage, and divided by the comparative solidity of rocks or tenacity of the soil, or in other words, multiplied by the comparative friability and solubility of the earth and rocks. This omits one important factor—time, because of the difficulty and uncertainty of applying it. It is well known, for instance, that in a rainfall of three inches, distributed over three days and nights, the excess of rainfall would scarcely swell the streams, whereas a rainfall of three inches, precipitated in an hour, would carry torrents of muddy water and sand into the rivers. To put this formula into algebraic form it would appear thus:

$$l = \frac{r\,p^2\,f}{t^2} \text{ or } l = \frac{r\,p^2}{s}$$

In which l represents the load of earth carried by the water; r is the excess of rainfall; p is the pitch of surface of the land; f is the comparative friability and solubility of the earth and rocks; s is the solidity or tenacity, and t is the time from the beginning of a rain to the end of it. However, this last factor (t) may be omitted, since it is only the excess of rainfall over evaporation and seepage which is considered. The term seepage, as used here, applies to that water which percolates through the earth deep enough to pass off in springs or subterranean streams, or lies quiet in the earth, and not to that water which soaks into the earth and is afterwards taken up by plants, or otherwise used or evaporated.

Repeated observations show that the waters of the Arkansas carry about one five-hundred-and-twenty-fifth of their bulk of earthy matter in suspension. A foot depth of water dipped from the Arkansas will, when settled, contain a deposit of nearly one-fortieth of an inch of soil. The amount in solution is undetermined as yet; but for the purposes of this article, may be figured at one-twentieth of the above amount, or enough to say the Arkansas carries one cubic foot of solid matter for every five hundred of water. The Kaw carries out one foot of solid matter for every six hundred and twenty-five cubic feet of water. The other streams of the State are estimated to carry off one foot of solid matter for every twelve hundred and fifty cubic feet of water.

Knowing, then, by experiment and deduction, the amount of water carried off by the different streams, and the comparative amount of solid matter contained therein, it is easy to arrive at the gross amount of earth removed from the State by its rivers in a year, thus: The Arkansas carries out 366,960 cubic feet of earth per hour, and in ten

months, or 300 days, it carries out 266,000,000 cubic feet, of which 155,000,000 are brought down from Colorado, leaving 111,000,000 cubic feet to be taken from the State. The Kaw carries out yearly 322,000,000, of which 135,000,000 comes from Colorado and Nebraska, leaving 187,000,000 as its work within the State. The other streams carry off 107,000,000 cubic feet in a year. The total amount carried off by all the rivers is 695,000,000 cubic feet, of which 405,000,000 are removed from the surface of the State of Kansas each year. This is 15,000,000 cubic yards; truly an enormous amount, if it were carted off by human agency.

RATE OF DENUDATION.

Enormous as this amount may seem, at this rate of denudation it would take 470 years to remove a single inch from the entire surface of the State, and 5,640 years to remove one foot. Within the historic period of the era of man—say 6,000 years—the amount of rock and soil removed from the surface of the land between the Missouri river and the mountains, averages only one foot in depth.

We can look back and see readily enough through the dim vista of 6,000 years, and are quite able to see the same rivers, and the same rolling prairies; the same north and south winds; the same heavy rains of summer and dryness of winter; the same buffalo grass, with its cropping herds of buffalo; the same sparse cottonwoods and willows near the streams; the same limestone ledges in the western part of the State; the same sandstones and fire-clay in the center; the same traces of coal in the southeast. Some of the flinty-capped hills of Greenwood, Saline and other counties may seem now a very little taller than then, and an occasional sand-hill, south of the Arkansas, may be in a new position, but in general, the topography and climate are very much the same; except that now the earth is drier, there is less water in the rivers, and denudation is less rapid than then.

Since the last glacial epoch, assuming that the height of the glacial period was when the earth's perihelion occurred at or shortly after the summer solstice, say 11,342 years ago, the amount of degradation has scarcely reached an average of two feet. Can there be a more forcible argument presented to show that time is long? Truly, "the mills of the gods grind slowly; yet they grind exceeding small."

There has never been a time when our long, broad, tortuous valleys were filled to the brim with the waters of a foaming, rushing, abiding river. If there are evidences at the base of any cliff of its having been washed by water, it is because the little stream, now somewhere near the middle of the valley, was once washing its base. Most small rivers and streams, in the course of time, travel all over their valleys. For at every bend a stream is constantly encroaching upon the further bank and building up the near one. Constant change of this kind will cause a stream, in the course of time, to touch every part of the valley bottom, even to washing the base of an occasional bluff. The width that valleys now have has been attained by the slow process of weathering, at a rate, perhaps, not to exceed one or two inches in a century. The alluvial soil that fills the bottoms has been washed there from the uplands, and blown there by the winds, and blackened by animal and vegetable humus and the products of prairie fires.

But the evidences at hand show that a depth of 3,170 feet over the entire State has been washed away. At the rate of our calculation, which, in past æons, at least, will not probably hold good, this would require nearly 18,000,000 years to remove what has been removed. This is equal to 840 great perihelional cycles or Platonic years; 840 times that this land has endured a warm, sometimes a subtropical climate; 840 times that it has undergone the rigors of a glacial period, or been nearly immersed in the sea *since the deposition of the pliocene tertiary.* The mind stands appalled at the magnitude and meaning of these figures.

Was the rate of erosion during the great Platonic winter in the Arctic regions, or

glacial period, as it is called, the same as at present? We judge of the past by the present. During our present annual winters, when the earth is frozen, the land covered with snow, and the rivers low and dry, erosion is reduced to a minimum. During the glacial period, evidence is not wanting of the presence of vast fields of ice as far south as 39° in the eastern part of the State, perhaps not during the last glacial period, but at other former times. North of lat. 39°, then, as in the headwaters of the Kaw, it is reasonable to presume that erosion would be less rapid; while farther south—as in the valleys of the Neosho and Arkansas, in consequence of the melting of much snow—erosion must have been greater. Following each glacial period in the great Platonic springtime, during the disappearance of the ice, and the greatly increased annual rainfall of those periods, even up to a few thousand years ago, erosion should be somewhat greater. Yet on the other hand, considerable soil and some bowlders have been deposited in northeastern Kansas by the action of the Missouri and by ice from the regions of the north, perhaps enough to neutralize the increased erosion. These considerations only modify the length of time of our calculation, and do not nullify it.

II.—*The Agency of Air.*

Air, like water, acts in a two-fold capacity: *First*, by taking up, on decomposition, the elementary constituents of the rocks; and *second*, by taking up and holding in suspense, and carrying bodily, particles of earth, sand, etc. It acts as an auxiliary to water by leveling the hills and filling the rivers; but it also carries earth entirely and forever out of the State.

It is known that, though the prevailing winds be north and south, the general tendency is from the west and toward the east. A particle of sand, though it may be blown north and south across the State a thousand times, will ultimately find its way out of the State toward the east; but by that time it has become worn so fine and has apparently so little grit as to be scarcely recognizable as a former resident of Kansas. Did it come from Colorado? Perhaps; but certainly not from beyond the Rockies.

As to the *amount* of soil that is removed, there are no statistics that are at all trustworthy. Let it suffice to say that exposed situations lose the most, and sheltered situations receive the most. Kansas is an exposed State, therefore it loses more soil than it receives, especially in the west. If it be admitted for the sake of argument, that even the one-thousandth part of an inch be removed in the course of one of our three-day dust storms, and that there are four such storms in a year, it will be seen that one inch would be removed in 250 years, which is twice as fast as the rate of erosion by water.

ILLUSTRATION.

During the spring of 1880 a notable dry dust storm, with a southwest wind, took place, that raised vast clouds of coarse sand, fine sand, and dust, the last two to great heights, and to such an extent as to partially obscure the sun all over the State of Kansas. At its close, a deposit of fine dust was observed to have taken place in Kansas City, St. Joseph, and even as far east as St. Louis. In conversation subsequently with our lamented Prof. Thomas, I learned from him that he caught some of the fine dust that fell in Topeka the night after the storm ended, examined it in the microscope, and found it to consist almost entirely of finely-comminuted silica; but where it came from he had no idea. I, on the other hand, at that time in Barton county, observed that on level prairies, all unprotected loose soil, mainly sand and light loam, even down to the grass roots, was taken up high in air and carried off; but where it went to I had no idea. Certainly an equal amount was not deposited from the opposite direction. Similar storms are quite frequent in western Kansas.

DEDUCTION.

The air, then, is an important factor in the removal of soil; though the rate of removal may not be computed.

RATE OF DEPOSITION.

The time required for deposition of the sedimentary rocks must greatly exceed that required for removal. For, the ocean being so much greater than the land, any quantity of soil removed from the land becomes very thin when spread out over the floor of the ocean. However, the rate of deposition is always very unequal, according to the varying conditions; and we know not what the conditions may have been during deposition of any of our older strata.

Evidences are abundant, showing that at various periods of the earth's development, portions of this continent were elevated above the surface of the sea, and removal of deposits continued, often until a greater depth of rock was removed than we have considered in this article, requiring either a greater time or more violent forces at work; and again, the land would become submerged, and remain buried until additional great depths of deposition had taken place, and new rocks were formed; thus showing repeated formation and removal of vast thicknesses of solid rock. If this be true of other parts, why not of Kansas?

AGE.

Counting time necessary for such successive deposits and removals, not counting varying conditions, can we safely estimate that, since disintegration and deposition first began on the igneous foundation rocks of Kansas, less than several hundred million years could have elapsed? Indeed it was probably very far beyond that toward eternity.

Time is long, and life is fleeting.

CLOSE.

In closing this paper, let me urge upon scientists in different parts of the State that they make occasional note of the following points: Breadth and depth of streams near where they live, at stated times; velocity of current, found by throwing in a chip, and noting time taken to pass a given point whose distance is known; amount of sediment obtained from a measured quantity of water; weight of residue obtained on boiling the water away; length of time the stream runs during the year, and time of year. Such observations, faithfully taken and recorded, will be very interesting and valuable.

SECOND CONTRIBUTION TO THE HERPETOLOGY OF KANSAS, WITH OBSERVATIONS ON THE KANSAS FAUNA.

BY F. W. CRAGIN, SC. B.

The list herewith given includes recent additions to my "Catalogue of Kansas Reptiles and Batrachians,"* together with further notes on certain species embraced in that catalogue.

For the identification of several of the species herein reported, I am indebted to Prof. E. D. Cope.

The remarks following the list are a revision and extension of notes, originally drawn up in the winter of 1880–81, to accompany the catalogue above mentioned, but finally withheld in order that the conclusions set forth in them might be made both more accurate and fuller. They make, even now, no claim to completeness.

Lack of time prevents me from entering here upon a full discussion of the details upon which these conclusions are based; but this I hope soon to be able to do in another paper.

*Transactions Kas. Acad. Sci., Vol. VII, p. 114.

Cistudo ornata, Ag.: Western Box-tortoise.—This little land tortoise is so abundant in some sections of southern Kansas, (*e. g.*, Harper and Barber counties,) as to amount to a nuisance as a cumberer of the ground.

It will probably have to be reduced to the rank of a variety, under *C. Carolinensis*, Linn. (=*C. clausa*, Gm.)

Chrysemys Belli, Gray: Bell's Tortoise.—Although this species, under the name of *Chrysemys Oregonensis*, was included in my "Preliminary Catalogue of Kansas Reptiles and Batrachians," (Transac. Kas. Acad. Sci., Vol. VII, 1881,) on the ground of its known general distribution, I was then unable to present any actual record of its occurrence within the State. I now find it to be the common *Chrysemys* of the streams in Shawnee county. It has also been submitted from Neosho Falls by Col. N. S. Goss, and I have taken it in Lake Farland, McPherson county. Through the kindness of Prof. Popenoe, of the State Agricultural College, I have also been able to examine specimens collected in the vicinity of Manhattan. In Dr. Yarrow's "Check-list of North-American Reptilia and Batrachia," I find the species recorded from the Republican river.

Chrysemys picta, Herm.: Painted Tortoise.—It now appears that the *C. Bellii* recorded by Agassiz (Contrib. Nat. Hist. U. S.) as abundant in western Missouri, and so quoted in the "Preliminary Catalogue" under the name *C. picta*, was probably the preceding species. But among the specimens from Neosho Falls, Kansas, submitted by Col. Goss, is one of the true *C. picta*, enabling me to retain the species as an undoubted member of the Kansas fauna.

Malacoclemmys Le Sueuri, Gray: Le Sueur's Map Turtle.—This is a common species in the Kansas river at Topeka. I have seen also, by favor of Prof. Popenoe, a specimen collected near Manhattan, and the species occurs in the collection from Neosho Falls from Col. N. S. Goss.

Pseudemys elegans, Pr. Max. Wied.: Red-Eared Terrapin.—A large specimen of this superb tortoise, "alive," though decapitated, and showing the marks of sharp teeth, was recently found by the writer upon the bank of Shunganunga creek near Topeka. It shows that even the best equipped specimens of these armor-clad reptiles sometimes fall a prey to the minks or other carnivorous mammals of our western streams. A young living specimen collected near Geuda Springs, has been received from Messrs. Harry and Walter Vrooman; and a third specimen is in the collections of the Kansas Academy of Science, contributed from Neosho Falls by Col. N. S. Goss.

Cinosternum Pennsylvanicum, Bosc.: Eastern Mud Turtle.—Through the courtesy of Prof. Popenoe, I have been able to examine the tortoises in the cabinet of the State Agricultural College. Among them I find a single specimen of this species. It was taken in Trego county by Mr. S. C. Mason.

Sceloporus undulatus, Harl., var. *Thayeri*, B. & G.: Thayer's Alligator Lizard.—Received from McPherson county through Dr. John Rundström.

Sceloporus consobrinus, B. & G.: Marcy's Alligator Lizard.—In my former list I could quote only a Nebraska and an Indian Territory record as evidence that this lizard belonged to the Kansas fauna. A specimen from central Kansas has since been contributed to the Washburn zoölogical cabinet by Mr. Jerry B. Fields. It is a female, and represents, *fide* Prof. Cope, *S. Garmani*, Boul.

Cnemidophorus tessellatus, Say: Tessellated Swift.—The occurrence of this species in Kansas was hardly expected; but a specimen of the typical variety has been sent me from McPherson county, by Dr. John Rundström.

Eumeces fasciatus, Linn: Blue-tailed Skink.—A considerable number of specimens from Neosho Falls, presented by Col. N. S. Goss to Washburn College and the Kansas Academy of Science, includes the *erythrocephalus*, *quinquelineatus* and *fasciatus* phases, or rather ages, which were mistaken for distinct species by Dr. Holbrook.

Eumeces multivirgatus, Hallowell.—Neosho Falls; collected by Col. N. S. Goss. This skink was included in the supplement of my preliminary catalogue only as one rather likely to be found in Kansas.

Tropidonotus leberis, Linn., var. *Grahamii*, B. & G.: Graham's Queen Snake.—Neosho Falls: collected by Col. N. S. Goss.

Storeria lineata, Hallowell: Line Snake.—This is the *Tropidoelonium lineatum* of my preliminary catalogue. It proves to be one of the commonest serpents of Kansas. Every State has its "School-boy's Snake," a snake of small size and meek demeanor, though a horror to the uninitiated, which the untamed urchin of school and field carries about in his pocket or fist for purposes of terrorism. This "School-boy's Snake" of Kansas is the Line Snake.

Eutænia sirtalis, Linn., var. *Pickeringii*, B. & G.: Pickering's Garter Snake.—McPherson county, from Dr. John Rundström.

Eutænia sirtalis, Linn., var. *obscura*, Cope MSS.—Dr. Yarrow's Check-list shows that this variety of the Garter Snake ranges over the entire area of the United States. Eight of the specimens appear to have come from Kansas, the following localities being recorded: Cimarron river, a point between the Cimarron and the Arkansas, Republican river, and Little Blue river.

Eutænia proxima, Say: Long's Garter Snake.—Dr. Yarrow records a specimen from Fort Riley, Kansas.

Pituophis catenifer, Blainv., var. bellona, B. & G.: Western Bull Snake.—This species also is recorded from Fort Riley in Dr. Yarrow's Check-list.

Elaphis quadrivittatus, Holbr.: Chicken Snake.—Dr. Yarrow's record, "Kansas" for this snake, adds another southern species to a fauna which, though a *prairie* fauna, has already shown that it has much in common with the Austroriparian.

Cyclophis æstivus, Linn.: Southern Green Snake.—Among the specimens submitted by Col. N. S. Goss is one of this species. It is from Neosho Falls. A second specimen of uncertain locality in the collection of the Topeka Free Library was presented with other Kansas specimens, and was probably taken in Kansas. A third specimen seems to have been taken at Great Bend by Messrs. E. G. Buckland and H. B. Torrey. This is another Austroriparian species.

Tantilla Hallowellii, Cope: Hallowell's Tantilla.—This species was originally described in 1856 as a variety of *T. gracilis* by Dr. Hallowell from a specimen collected in Kansas by Dr. Hammond, (Proceed. Phila. Acad. Nat. Sci., 1856, p. 246,) and afterwards named as distinct by Prof. Cope. (Proceed. Phila. Acad. Nat. Sci., 1860, p. 77.) Mr. Garman, of the Cambridge Museum of Comparative Zoölogy, in his excellent account of the *Ophidia* of North America, "North American Reptiles, Part I," reduces it to a variety under *T. gracilis*. As it does not appear that any of the allusions to this species have been based upon more than one or two specimens, it seems necessary to await the accession of further material before the specific identity of *Hallowellii* with *gracilis* can be either asserted or denied.

Sistrurus catenatus, Raf.: Massasauga.—Taken in Ford county by the writer. It is recorded from the Verdigris river [Kansas?] in Dr. Yarrow's Check-list. The Ford county specimen is typical, and the locality is the most westerly known for the species. This is the *Caudisona tergemina* (erroneously printed "tergermina" in my "Preliminary Catalogue.") Mr. Garman's substitution of a fourth generic name in the stead of either of the three to which the plated-headed rattlesnakes had previously been referred, seems to have been the proper and indeed the only logical remedy for the confusion that existed, inasmuch as no new genus, nor even sub-genus, had previously been created for those forms, the generic names previously used for them being preoccupied and long used with a very different signification.

Amblystoma microstoma, Cope: Small-mouthed Salamander.—A specimen of this sala-

mander occeurs in Col. N. S. Goss's contribution. Its locality is, not quite certainly, but probably, Neosho Falls.

Necturus maculatus, Raf.: Water Puppy.—Several specimens from Neosho Falls, in the collection submitted by Col. Goss, are the first Kansas specimens that I have seen. The species was previously reported to me in letter by Prof. F. H. Snow, who stated that it had been taken in Allen county, near Iola, by Mr. Bert Casmire, a student of the State University.

The minuter details of the relations of Kansas to the four great faunal regions—Central, Eastern, Austroriparian, and Sonoran—that enter or approach its borders, are yet to be ascertained.

In problems of faunal relations, we can direct our attention to no department of zoölogy more profitably than to that of herpetology, the intimate relations of reptiles and batrachians to their climatic and topographical surroundings (partly dependent on the fact that they do not migrate), rendering them exceptionally important factors in all problems of faunal relations.

This fact has constantly been kept in mind in my studies of the reptilian fauna of Kansas, and the conclusions primarily derived from the study of that fauna have been frequently reviewed in the light of observations made in the course of my studies upon other groups of Kansas vertebrates and invertebrates, and further tested by the published writings of the various naturalists who have studied portions of the Kansas fauna.

While Kansas embraces features of each of the four faunal regions above mentioned, no part of its territory is the exclusive property of one. Faunal regions are rarely sharply defined. They cast their shadows beyond them, and beyond each shadow is spread a penumbra. To a mingling of faunal shadow and penumbra from the regions above mentioned this area owes the heterogeneous aspect of its fauna.

In its flora, too, we see mingled with the dominant vegetation of the Central and Eastern regions varying shades of the Austroriparian, and a few faint flecks of the Sonoran.

Of reptiles and batrachians, whose distribution corresponds nearly with a single one of the four regions concerned, or with a part of such region, we find in Kansas of the Austroriparian 14, Central 11, Eastern 10, and Sonoran 3.

This observation might seem to point to the Austroriparian as the dominant factor, but it by no means represents the true faunal relations of the State. It plainly asserts that the fauna of Kansas is deeply shaded with Austroriparian. But when we consider the ratio of each of the above numbers to the entire number of species peculiar to the corresponding region, and take into account species common to two or more regions, we see at once that the herpetological aspect of Kansas is mainly Central and Eastern.

Two or three, only, of the many reptiles characteristic of the Sonoran region, together with a few which that region shares with the Central on one hand, or with the Austroriparian on the other, extending into Kansas, show its distant Sonoran relationship.

The above observations pertain to the Kansas fauna as a whole, all Kansas species being viewed as common to the entire State. But comparatively few species range over the entire area of Kansas in upland and valley alike, and to gain an adequate conception of the Kansas fauna, even in its relations to natural faunæ, we must consider its intralimital relations, and take into account other groups than those of reptiles and batrachians.

Full details of distribution have as yet been made out for but few species of Kansas animals; but enough has been done to warrant the following conclusions as to the special relations of the Kansas fauna:

1. That Kansas cannot, as a whole, be included in any single faunal region of the four that enter or approach its borders.

2. That it possesses some faunal features in common with each of these regions.

3. That the only faunal region that contributes a considerable majority of its characteristic species to any portion of Kansas, is the Central.

4. That the plains of Kansas, west of the ninety-seventh meridian, possess a large majority—in reptiles and batrachians, perhaps all—of the characteristic species of the Central region, and that while the Central fauna cannot be regarded as extending in full force, except locally, over the plains east of that meridian, many of its characteristic forms occur abundantly further east, some of them ranging to the Missouri river.

5. That even in the purest portions of the Central fauna in Kansas, appear slight manifestations of Sonoran, and others of Eastern and Austroriparian affinities.

6. That the prairie fauna of Kansas, east of the ninety-seventh meridian, is a heterogeneous assemblage of Central, Eastern, and Austroriparian forms, among which the Central predominate.

7. That it is on the "bottoms" and wooded bluffs, and their immediate vicinity, that the constituency of the Eastern fauna in Kansas is mainly expressed, and that this constituency includes comparatively little that is really characteristic of the aquatic phase of that fauna, while representing fairly well the terrestrial aspect of the same.

8. That the lacking elements of the Eastern fauna in these low and wooded tracts, are largely replaced, in valleys of the Missouri drainage, by Central, and in those of the Arkansas drainage, by Austroriparian and Central elements.

9. That the constituency of the Eastern fauna in Kansas diminishes westward, and is nearly or quite lost in the Central ere it reaches our western border.

10. That the Kansas constituency of the Austroriparian fauna lacks numerous characteristic forms of that fauna, and is constantly intermingled with Eastern and Central elements.

11. That this constituency is fullest in the valleys of the lower Arkansas drainage—notably of the Spring, Neosho, Verdigris, and Fall rivers—and represents only the Louisianian and Texan districts.

PRELIMINARY NOTE ON THE ORIGIN AND MATURATION OF THE OVUM IN PORCELLIO.

BY F. W. CRAGIN, SC.B.

The early history of the ovum in *Arthropoda* is of peculiar interest in relation to Balfour's theory of polar globules.

In the winter and spring of 1881–2, I undertook an investigation regarding the fate of the germinative vesicle in *Porcellio*, two writers (whose names now escape me) having claimed to have witnessed a polar globule in this or an allied isopod genus, but their statements being not sufficiently detailed to inspire confidence that the phenomenon witnessed was actually what they inferred it to be.

While the results of my studies were far from conclusive (and I have since been unable to resume the investigation), they indicate that events at least *potentially equivalent* to the formation of polar globules—viz., degradation and partial elimination of the germinative vesicle—*probably* take place in the maturation of the ovum in *Porcellio*.

The ovary in *Porcellio* is a subcylindrical sac, constituting a conspicuous anatomical feature on either side of and parallel to, the alimentary canal. When not distended with eggs, its diameter parallel to the axis of the upper oviduct is contained seven or eight times in its length. Its wall is a thin, transparent and colorless membrane, apparently syncytial, though perhaps really a pavement epithelium with delicate and but slightly differentiated cell-walls.

The nuclei are lenzitoid and extremely flattened. Seen from above, they present various subcircular outlines, which are often asymmetrical. The nucleoli are comparatively small, though well defined, and are often excentric.

In the suspensory ribbons, which are simply elongations of the ovary wall, the sparingly present nuclei are so distributed as apparently to forbid a cellular structure—several nuclei being often huddled together in one part of the ribbon, while in adjacent intervals there are none at all.

The oviduct is placed somewhat nearer the posterior than the anterior end of the ovary, its walls being composed of broadly columnar epithelium, and its ovarian end being inflated to form a receptaculum seminis, whose junction with the ovary, being in the line of the germogen, divides the latter into an anterior and a posterior arm.

Whether of syncytial or cellular origin, numerous germinal cells may be seen in the germinal tract of the *Porcellio* ovary, and since these appear to originate from indefinite germ-like bodies, the term germogen may be conveniently retained.

In the smaller germinal cells the nucleus is relatively small, sometimes even indistinguishable, but in those which are destined to become eggs, the nucleus grows more rapidly than the cell-body, and is at length relatively large. Prior to the escape of the germinal cell into the general ovarian cavity, its nucleus is seen to be surrounded with a densely granular zone which, spreading outwardly as the cell grows, at length reaches the cell-wall.

In the course of this growth, the nucleolus sometimes divides into two or three similar and smaller nucleoli, and the eggs themselves become invested with a follicular epithelium. This consists of small ovate to cylindrical cells, arranged in columnar fashion in a single (or in part double) layer, closely investing each ovum, the polygonal spaces thus temporarily left being usually occupied by a few isolated cells similar to those of the follicles. The entire follicular structure is definitely limited by a layer of cells quite like that which constitutes the several follicles, and, in fact, partly composed of the outer portions of those follicles. The cells destined to form the follicles are at first loosely scattered in the region about the ovum to which latter it would seem that they migrate later. Their final origin was not determined. As they attain maturity, the ova become more or less polygonal by pressure and are then usually arranged in two rows, with rarely a part of a third completely filling the ovary. Some of them undergo retrogressive development, the function of such retrogression being probably connected with nourishing the true ova, this being partly accomplished also by the follicular epithelium, and perhaps further aided by the product of a peculiar gland-like streak* which extends along the side of the ovarian tube opposite that which the germogen occupies, appears to be of protoplasmic nature, though of yellowish brown color, contains numerous scattered granules and larger irregular and ill-defined masses, and possibly represents a functional vitellarium.

In this rapidly growing condition of the ovarian egg the germinal vesicle is central in its position, and relatively large as compared with the ovum. After the ovum has attained its growth, the germinal vesicle leaves the center, becoming relatively smaller and at last reaches the surface of the ovum. There is apparently a narrow liquid zone between the outer limit of the protoplasm of the egg and the chorion, and I have not observed the nucleus to pass entirely across this zone so as to be in actual contact with the chorion. I have, however, observed it to push out into this space, the projected portion still covered with a thin layer of granular protoplasm, and thus making a considerable protruberance. Whether this was really what it seemed to be, viz., a preliminary

*This streak was noticed only while the ova were in process of maturation. While cellular structure, such as may be observed in most glands, was not made out, it may have been present, obscured by the cell products, as the streak was not studied in section. I first thought the structure to be of a *detrital* nature, as further investigation may yet prove it to be.

step in the elimination of a polar globule or its functional equivalent, liquid or solid, I cannot say, as I was unable to pursue the investigation further at that time. But until further study of the fate of the germative vesicle can be made, I hold the provisional opinion that this migration and protrusion, taken in connection with the condition of the germative vesicle in this and other ova simultaneously taken from the same ovary and treated with picro-carmine, represented an initial phase of such an elimination.

The germinative vesicle of the particular ovum concerned in the above-mentioned protuberance had, at the time of that protuberance, one large and several accessory nucleoli, of which the former, at least, had one large vacuole.

The following is an account of the general appearance presented by the germinative vesicle in this and other ova of the same brood, the growth of all of which must have been arrested at nearly the same stage of development: It possessed a distinct but thin, transparent and flaccid limiting membrane. Visible beneath this membrane was a broad-meshed, but most delicate, lattice, composed of exceedingly fine granules — much finer than those in the protoplasm of the general egg body — and appearing much like a dissolving remnant of the intranuclear trestle*. There were in each instance, besides the large nucleolus, several, sometimes upwards of thirty, accessory nucleoli. There was a marked relation between the number of these accessory nucleoli and their size. When numerous, they were all small; when few, two or three of them, at least, were relatively large. Both principal and accessory nucleoli were vacuolated. In a germinative vesicle with but eight accessory nucleoli, the principal nucleolus had one large vacuole of subangular outline, about which were other and minute vacuoles. In those with numerous accessory nucleoli, the vacuole had become so extremely large that the solid part was reduced to a spherical shell, converting the nucleolus into a mere vesicle, its wall, however, still much thicker than that of the germinative vesicle itself.

As migration of the germinative vesicle to the periphery of the ovum is a constant and indeed necessary step in the elimination of polar globules or their potential equivalents, and as this migration is universally accompanied by metamorphosis of the germinative vesicle, more or less distinctively retrogressive; and particularly in view of the researches of Van Beneden and Fol, who have shown that in the ovum of *Asteracanthion* the formation of nucleolar vacuoles and accessory nucleoli are phenomena characteristic of such retrogression, I regard it as probable that the migration and metamorphic appearances above noted indicate the ultimate partial elimination of the germinative vesicle in *Porcellio*.

I am by no means confident that the extreme aspect of the vacuolation which I have recorded was not an effect of the staining-reagent; but thus to explain the concomitant phenomena, is hardly possible, and the most reasonable conclusion seems, therefore, to be that to which I have already pointed, a conclusion which, I must humbly confess, lacks that most desirable element in scientific deductions — *certainty*. It is, then, with the hope that this conclusion may ere long be either verified or refuted by new experimental evidence, that it is here presented.

BOTANICAL ADDENDA FOR THE YEARS 1883 AND 1884.

BY PROF. J. H. CARRUTH, LAWRENCE.

The work of making a catalogue of the plants of Kansas is so nearly completed, and my salary as a State officer is so very meager, that I have done but little myself. I have found one plant, and two have come up in my garden. Mr. E. Bartholomew, of Rock-

*This trestle, or network, is a well-defined structure in the earlier history of the ovarian egg of *Porcellio*.

port, Rooks county, has been busy as heretofore with the plants of his county, and sent me the results, but few are new. Mr. Joseph Henry, of Salina, has sent me a few. The greater number (all but about ten) have come through the labor of Dr. J. H. Oyster, of Paola, Miami county, who has traveled in the south and west, as well as observed carefully in his own county. E. N. Plank, Esq., has traveled extensively, but I am unable to give the results of his observations.

Those not in Gray nor Wood, I mark with a †.

†1474. Helianthemum capitatum Nutt.; Linn county. Viola pubescens, var. eriocarpum Nutt.; W. Kansas. Ionidium lineare, reported doubtfully before, found in Wilson county.

†1475. Æsculus arguta Buckley. Lyon county and W. Kansas.

1476. Lespedeza angustifolia L. Miami county. Sometimes a var. of L. capitata.

1477. Trifolium stoloniferum Muhl. Miami county.

1478. Proserpinaca palustris L. Miami county.

1479. P. pectinata Lars. Miami county.

†1480. Œnothera linifolia Nutt. Labette county.

1481. Ludwigia polycarpa. Short and Peter. Miami county.

†1482. Cyclanthera dissecta. Garden. Lawrence.

†1483. Aster Drummondii Lindl. Miami county.

1484. Silphium terebinthaceum L. Reported as seen in Marion county by Mr. Frank Bush.

†1485. Aphanostephus Arkansanus Gray. Reported in the flora of N. A. as found in Kansas.

†1486. Boltonia latisquama Gr. Found near the mouth of Kansas river by Dr. C. C. Parry.

†1487. Franseria tomentosa Gr. W. Kas.

†1488. Artemisia annua. Garden and street, Lawrence.

1489. Artemisia caudata Mx. Miami county. (?)

†1490. Pyrrhopappus scaposus D.C. Miami county. (?)

1491. Arctostaphilus uva-ursi Spreng. Council Grove.

1492. Lysimachia quadrifolia L. Miami county.

1493. Plantago Rugelii Decne. Lawrence.

†1494. Lycopus lucidus, var. Americanus Gr.

†1495. Heliotropium tenellum Torr. E. Kan.

†1496. Solanum Torreyi Gr.

†1497. Asclepias stenophylla Gr. E. Kan.

†1498. Polygonum camporum Meisn.

†1499. Chenopodium Berlandieri Moq. Common. Heretofore supposed to be a small variety of C. alba.

1500. Euphorbia prostrata Ait. Miami county. Common, but not in Gray nor in Wood's Botanist and Florist, and therefore supposed to be thought a var. of E. humistrata.

†1501. Tragia ramosa Müll. Rooks county.

†1502. Argyrothamnia mercurialina Müll. Wilson county.

1503. Croton glandulosus L. Johnson and Sumner counties.

1504. Phyllanthus Carolinianus Walt. Miami county.

1505. Potamogeton amplifolius Tuck.

1506. Amianthium muscætoxicum Gr. Butler and Sedgwick counties.

†1507. Allium Nuttallii Watson.

†1508. Androstephium violaceum Torr. W. Kansas.

1509. Uvularia perfoliata L. Wyandotte county.

†1510. Carex marcida Boott. Rooks county.
1511. C. hystricina Willd. Salina.
†1512. Polypogon littoralis. Salina.
†1513. Aristida desmantha Rupt. Harper county.
1514. Eragrostis Purshii Schrad. Harper county and Salina.
†1515. Triticum glaucum. W. Kansas.

ERRATA.

Page 110, 21st line, for "gomatites" read *goniatites*; in 32d line, for "prunes" read *prunus*.

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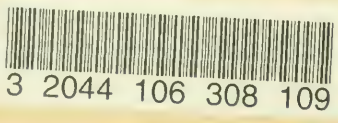
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